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NATURAL RESOURCE DAMAGE ASSESSMENT (NRDA) PLAN

SLAG INVESTIGATION
THE DOE RUN COMPANY LEAD SMELTER
HERCULANEUM, MISSOURI
DOCKET NO. RCRA-7-2000-0018
CERCLA-7-2000-0029

SEPTEMBER, 2001

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1 Introduction

This Natural Resource Damage Assessment Plan (Plan) is submitted to the United States Environmental Protection Agency (USEPA) – Region VII and the Missouri Department of Natural Resources (MDNR) by The Doe Run Resources Corporation (Doe Run) pursuant to the Administrative Order on Consent – Docket No. VII-99- (AOC) (date pending). This Plan has been written to fulfill requirements outlined in the AOC including the scope of work. The AOC and this Plan concern the slag pile storage area of the Doe Run lead smelter at 881 Main Street in Herculaneum, Jefferson County, Missouri (hereinafter referred to as the "Site"), as well as slag pile/surface water/sediment/groundwater areas potentially affected by the Site (Figure 1). Included in this investigation is the characterization of Joachim Creek and the Mississippi River floodplain as well as nearby portions of the Mississippi River (hereinafter referred to as the "Study Area") located adjacent to the Site. In addition to this Plan, other AOC required workplans include:

- Quality Assurance Project Plan (QAPP);
- Sampling and Analysis Plan (SAP);
- Health and Safety Plan;
- Community Soil Cleanup Plan;
- Community Blood Lead Plan;
- Interim Slag Pile Runoff Control Plan;
- Ecological Risk Assessment (ERA) Workplan; and
- Groundwater Monitoring Plan

References will be made to several of these documents with special attention given to the QAPP and SAP. All of the methodologies utilized to conduct the sampling and analyses of the various media and the techniques used to characterize the habitats associated with the Site are outlined in the QAPP and SAP.

The objectives of this Plan are to:

1) Outline the processes used to accurately define the scope and spatial extent of potential natural resources injuries at the Site, if any;
2) Describe important components of the Natural Resource Damage Assessment process; and
3) Describe the Habitat Equivalency Analysis concept used to estimate the level of injuries at the Site.

1.1 Doe Run Lead Smelter Background

The lead smelter has been in operation for over 100 years and is the largest smelter of its kind in the United States. The smelter is an active lead smelting facility, currently owned and operated by Doe Run. The Site is approximately 52 acres and consists of two main areas, the smelter plant and the slag pile. The Site is bordered on the east by the Mississippi River, on the west and north-northwest by Joachim Creek, on the north by the lead smelter, and on the south-southwest by Joachim Creek. A substantial portion of the slag pile is located in the floodplain wetlands of the Joachim Creek and Mississippi River.

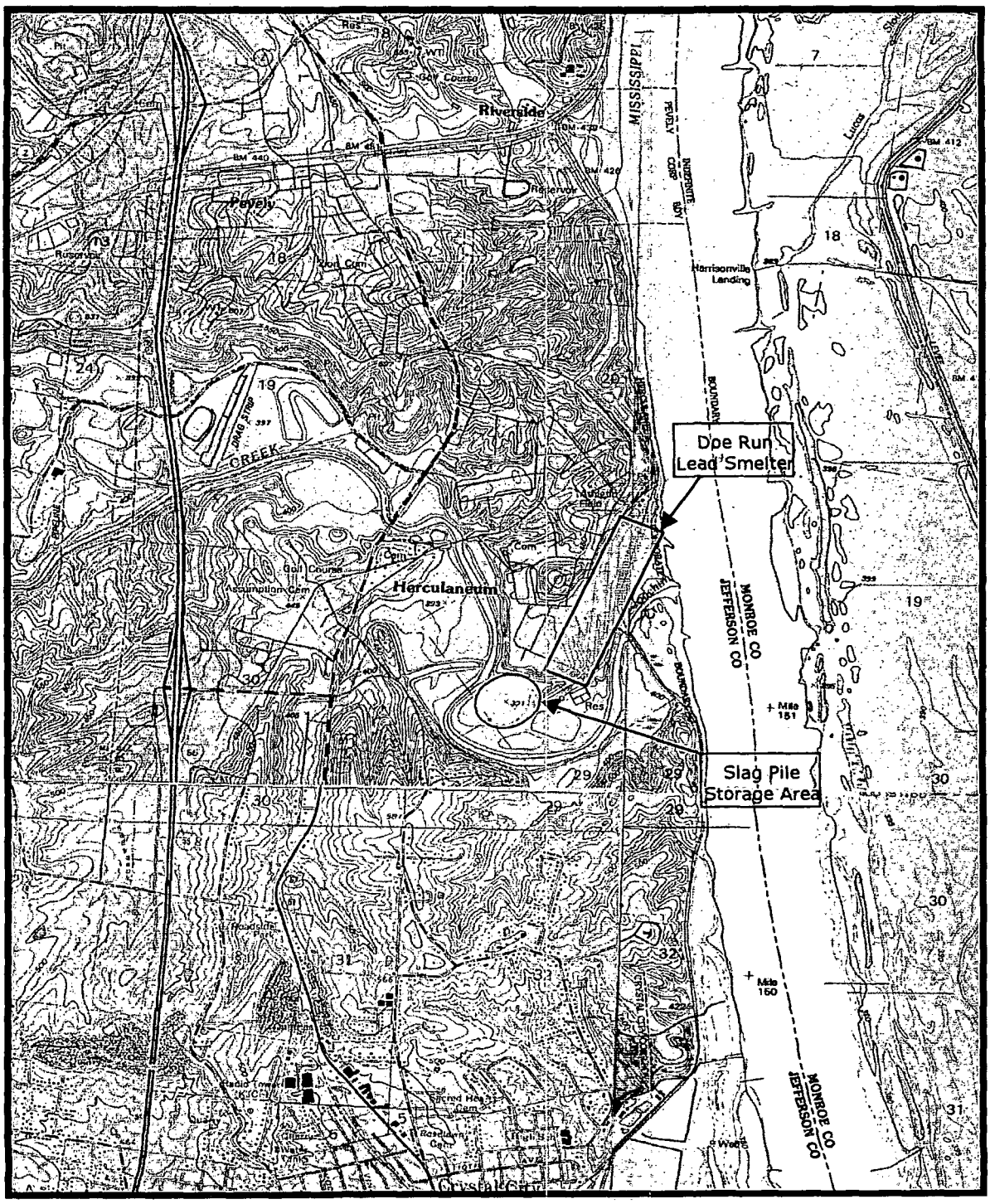


Figure 1

Site Map
Slag Investigation
The Doe Run Company Lead Smelter-Herculaneum, Missouri

Scale: 1"=2000'

Map Sources: U.S.G.S. Herculaneum, MO Quadrangle-1993
U.S.G.S. Festus, MO Quadrangle-1964 (photorevised 1982)
U.S.G.S. Selma, MO Quadrangle-1993
U.S.G.S. Valmeyer, IL Quadrangle-1993

1.1.1 Slag Formation and the Slag Pile

1.1.1.1 Slag Formation

When lead concentrate arrives at the smelter, it is dumped into a large feed hopper and mixed with fluxes and internally recycled lead-bearing materials such as baghouse fume. The resulting mixture is then tumbled to form pellets that are fed into the sinter machine. The sinter machine consists of a slowly moving grate that passes under a line of gas-fired burners. The lead concentrate pellets are layered onto the sinter machine grate with the bottom layer of pellets ignited by the gas burners. The combustion zone is slowly moved from the bottom to top by air pushed upward through the bed by large fans. Gases are stripped of all entrained dust and other impurities in the baghouses and then converted to commercial grade sulfuric acid in the acid plant. After the cakes of sinter are discharged from the sinter machine, the sinter is crushed and screened to a suitable size for the blast furnace (AOC).

Lead-bearing sinter is the main ingredient in the feed for the blast furnace. Sinter is mixed with coke and continuously fed through the tops of the blast furnaces. As the feed descends into the shaft of the furnace, it passes through blasts of hot air and gases. Carbon contained in the coke reacts with the hot air forming chemically reducing gases, reducing the sinter to molten lead. Flowing from the bottom of the blast furnace, the molten lead collects in special pots and is immediately transferred to the drossing department. At the same time, molten slag composed of reduction by-products is tapped from the furnace, granulated and returned to the sinter department as feedstock. Approximately 80% of the slag produced is reused as feedstock. The remaining 20% is sent to the slag storage pile when it is no longer of use as feedstock (AOC).

1.1.1.2 The Slag Pile

The Site, at various locations, is approximately 40 to 50 feet high and covers about 24 acres. The majority of the visible slag is very fine material. The heavy metals within the slag include arsenic, cadmium, copper, lead, nickel, and zinc. According to Doe Run, the slag material contains approximately 12-14% zinc and 1.5-2.5% lead, among other constituents. In early 1999, Doe Run constructed a drainage diversion ditch along the north side of the Site to divert any runoff from the area north of the pile. However, runoff in the ditch eventually enters Joachim Creek, as does precipitation falling directly onto the Site. There are no protective barriers to stop erosion during flood or storm events of slag material into nearby streams. The Mississippi River and Joachim Creek bottomlands are periodically flooded as a result of snow melt and seasonal storms.

A substantial portion of the Site is located in a special flood hazard area inundated by the 100-year flood. Aerial and ground view photographs of the slag pile taken by United States Fish and Wildlife Service (USFWS) personnel in March 1998 document flood waters of Joachim Creek in contact with the slag material. In 1993 during a major flood event, water reached several feet up the sides of the Site.

The slag material generated at the Herculaneum smelter is stored in a Metallic Minerals Waste Management Area that was permitted in 1992 under Missouri's Metallic Minerals Waste Management Act. According to the Missouri permit, the waste management area may occupy a total area of approximately 62 acres.

1.2 Slag Investigation Conceptual Strategy

As described on Figure 2, the sampling activities of the slag investigation (SI) will be integrated with the ERA and the NRDA. This integrated, conceptual strategy is consistent with the general management approach outlined in the AOC. Because of the incomplete knowledge of the Site and the iterative nature of the SI, additional data requirements and analyses may be identified throughout the process. Establishing a conceptual strategy at the beginning of the process, utilizing a Conceptual Site Model (CSM) and Data Quality Objectives (DQO) based approach, will serve to guide data collection activities toward the development of a common, comprehensive, end-point driven, risk management strategy for the Site.

The integrated SI, ERA and NRDA approach is based on a review of the historical data, the current condition of the Site, a preliminary CSM and the requirements set forth in the AOC. Recognizing that the investigative process typically follows an iterative path, a two-phased integrated approach was developed (Figure 2). A phased approach will efficiently fulfill data gaps identified during a review of existing physical, chemical and hydrogeologic data and Phase I and II investigation activities for both the baseline risk assessment (BRA) and NRDA.

SI investigative activities will be initiated following the approval of various workplans outlined in the AOC. Overall, the proposed phased approach includes filling data gaps to evaluate the "source-pathway-exposure" scenarios outlined in the preliminary CSM (Figure 3). At the completion of Phase I, a better understanding of area-specific as well as site-wide conditions will be developed in an effort to refine the preliminary CSM. Additionally, data gaps necessary to refine the CSM as part of Phase II will be identified.

1.3 Conceptual Site Model (CSM)

A preliminary CSM has been developed to illustrate preliminary interpretations of potential sources, pathways and exposure scenarios at the Site. The preliminary CSM, as shown on Figure 3, serves as the basis for the phased approach as conceptually described below. Ultimately, the CSM will serve as the basis for the NRDA and the BRA.

A CSM is defined as "a written description and visual representation of predicted relationships between receptors and the stressors (contaminants of potential concern) to which they may be exposed" (USEPA, 1997c and 1998b). The CSM is a very useful analysis and communication tool for a NRDA and a BRA, and is typically presented in a schematic figure. It is used to describe the relationship between potential chemical sources, chemical release and transport mechanisms, locations of potentially exposed receptors, and potential exposure routes.

A CSM is also useful for identifying and communicating data gaps that can be addressed with additional sampling. For Phase I, a preliminary CSM has been developed from historical and preliminary data (Figure 3). This preliminary CSM should be thought of as a "working model". As the NRDA and BRA data sets are refined through the Phase II of the SI, the CSM will be refined with additional information regarding the sources of contaminants of potential concern (COPCs), and complete transport and exposure pathways. The CSM will also support the NRDA preassessment screen.

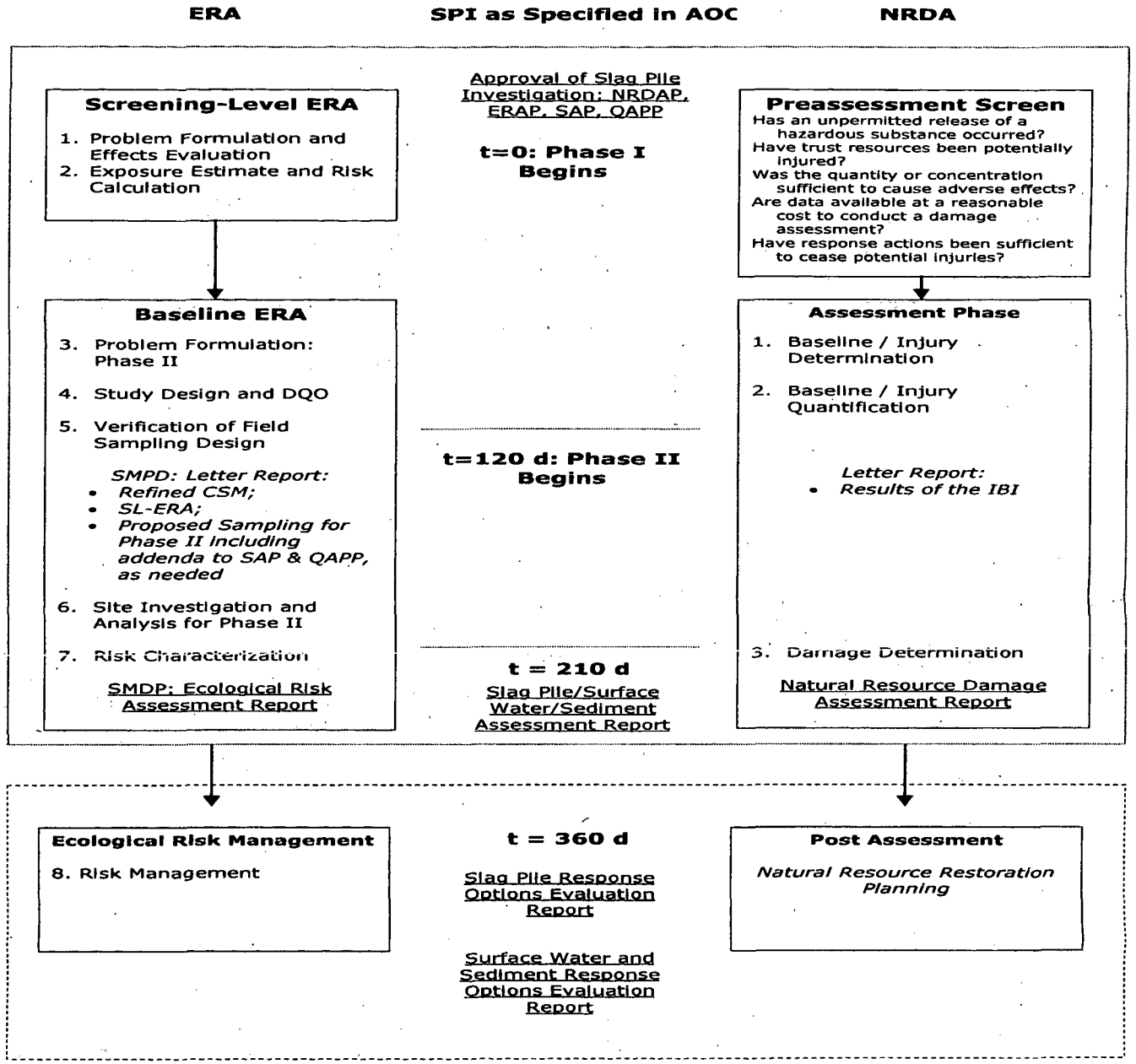
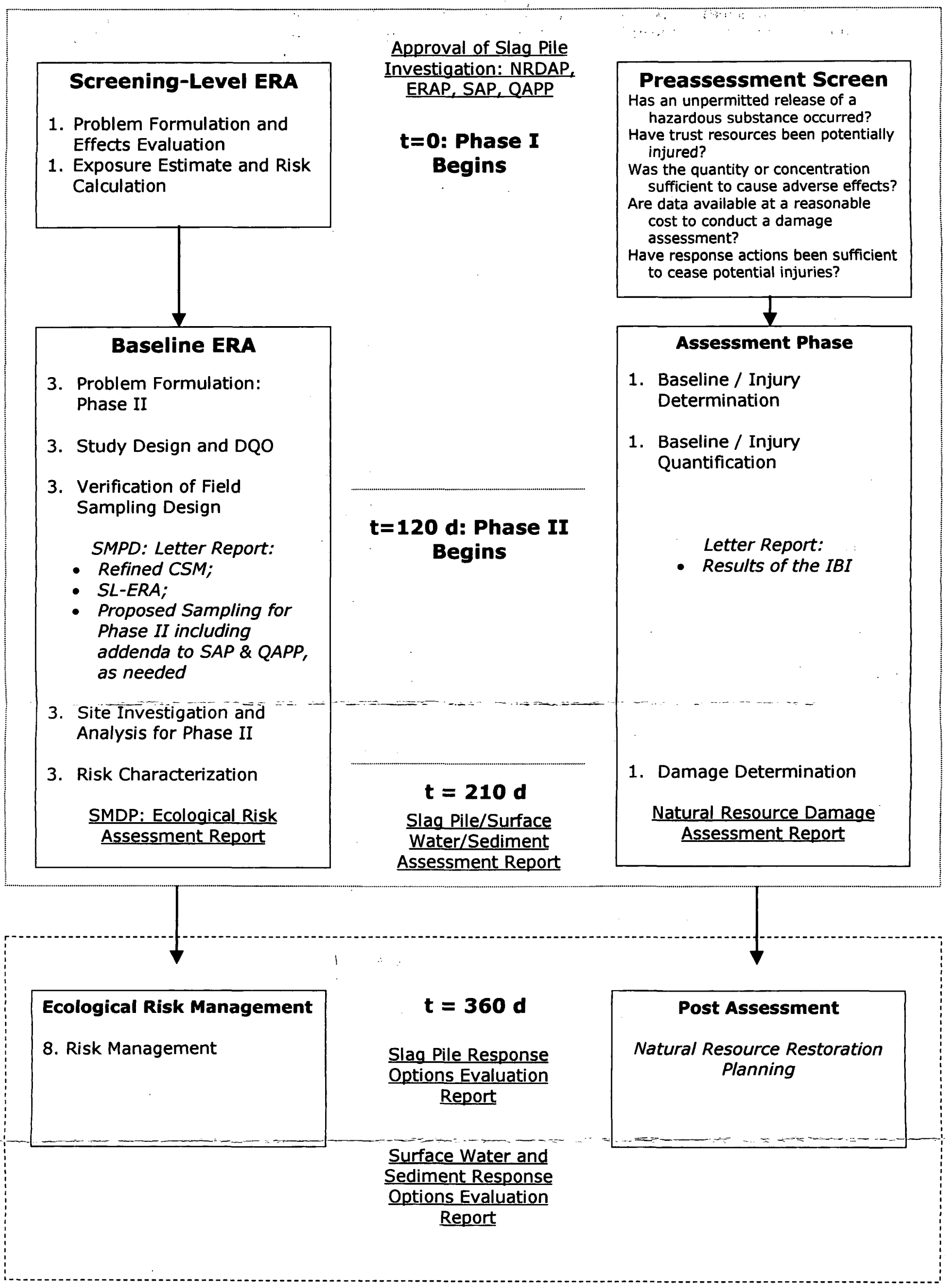


Figure 2
Conceptual design for the integration of the ERA and NRDA within the project objectives and deliverables specified by the AOC for the Slag Pile/Surface Water/Sediment/Groundwater investigation. Underlined text indicates deliverables from Doe Run specified by the AOC, while text in italics indicates interim deliverables in which input from the BTAG and Trustees are required.



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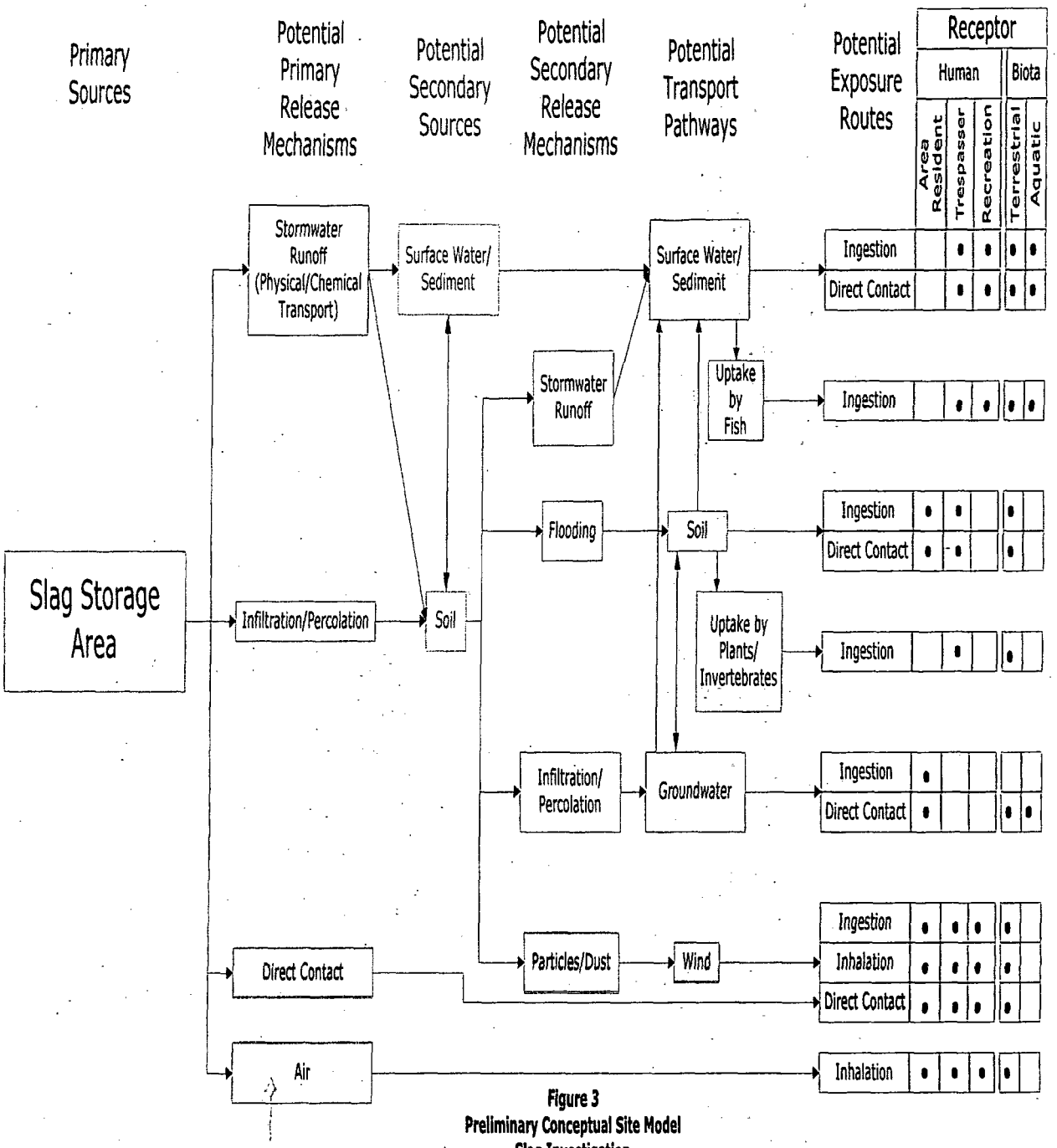

Figure 3
Preliminary Conceptual Site Model
Slag Investigation
The Doe Run Company Lead Smelter-Herculaneum, Missouri

1.4 NRDA Plan Outline

For the remainder of the Plan, Section 2 describes the four-step process of an NRDA in detail. Each of these four steps will be followed regarding the SI.

Section 3 of this Plan outlines the strategies and protocols utilized to perform the preassessment screen and identify the potentially-exposed habitats and resources during the SI. To establish baseline and determine if potential injury has occurred, techniques, such as the Index of Biotic Integrity, Stream Habitat Assessment Procedures and physical characterization/water quality surveying, are described. Additionally, a description of how terrestrial habitats will be characterized using floristic surveys is outlined.

Part of the NRDA process is to scale natural resource injury if impacts have occurred. To scale injuries (if any) that may have occurred in the Study Area, the use of Habitat Equivalency Analysis has been proposed. Section 4 briefly discusses the habitat equivalency concept to assure that all parties involved with the SI have that same understanding of the process.

This Plan has been prepared specific to the slag pile area, Joachim Creek and nearby Mississippi River. However, the approaches outlined in the plan are general and flexible to address other areas of potential concern identified resulting from implementing the workplans described in Section 1.0.

2 Overview of the Natural Resource Damage Assessment Process

Compensation for natural resource damages resulting from the release of oil or a hazardous substance may be sought through a Natural Resource Damage Assessment (NRDA). Regulations that provide for the application of a NRDA include the *Clean Water Act* (CWA; 33 U.S.C. 1251 et seq.) and the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA; 43 CFR Part 11). The goal of the NRDA process is to make the environment and public whole for injury to or loss of natural resources and services resulting from a release, or threat of release, of oil or hazardous substances into the environment. "Natural resources means land, fish, wildlife, biota, air, surface water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in Trust by, appertaining to, or are otherwise controlled by the United States (including the resources of the Exclusive Economic Zone), any State or local government or Indian tribe, or foreign government, as defined in Section 1001(20) of OPA (33 U.S.C. 2701[20])."

Trustees have the responsibility for assessing injury and conducting any actions necessary to restore, rehabilitate or replace injured natural resources, and to fully compensate the public for the lost use of the resource. *Injury* is defined to include adverse effects on the resource, including effects on biological resources. *Damage* is the value of the injured resources. The damage recovery can include the cost of restoration and also the value of the interim lost use of the resource. Damages may be in the form of restoration projects, monetary settlements or a combination of both. The damage recovery must be used to restore, rehabilitate, replace, or acquire the equivalent of the injured natural resources.

For the purposes of the NRDA associated with the Site, the U.S. Department of Interior (DOI) NRDA regulations may be implemented per the *Administrative Order by Consent Pursuant to Sections 104, 107 and 122 of CERCLA*: "In conjunction with the ERA described above, Doe Run shall gather sufficient data, samples, and other information, in cooperation with the Natural Resource Trustees, necessary for a NRDA of the affected area. Said NRDA shall be conducted cooperatively and consistent with CERCLA, the NCP, and the NRDA regulations promulgated by the U.S. Department of the Interior, 43 C.F.R. Part 11. Doe Run shall have the opportunity to suggest, and present justification for, alternative procedures, values, and assumptions to be used in the NRDA. The Natural Resource Trustees shall consider said alternatives to the extent allowed by law, regulation, applicable guidance and accepted practices. However, approval of said alternatives remains within the authority and discretion of the Natural Resource Trustees".

The framework for a NRDA under the DOI regulations call for the following four sequential phases in the assessment of damages (Figure 4):

Phase 1: Preassessment Screen;

Phase 2: Assessment Plan;

Phase 3: Assessment Implementation; and

Phase 4: Post-Assessment.

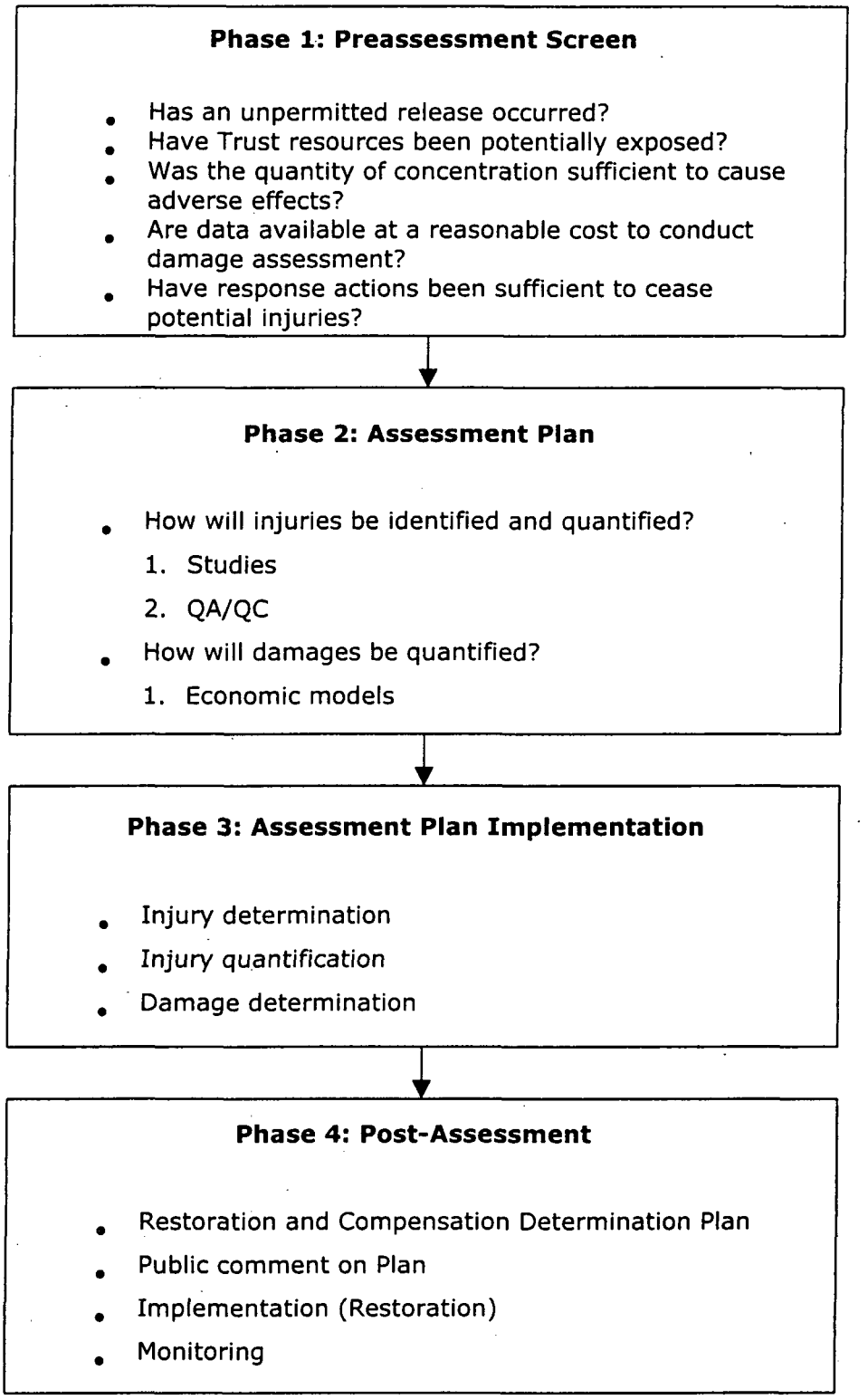

Figure 4.
Phases of the Natural Resource Damage Assessment process from the Department of Interior Rule (43 CFR 11).

The remainder of this section will describe the components of each phase of the NRDA process, and the potential methods that may be used to complete the damage assessment process.

2.1 Preassessment Screen of Natural Resource Damages

A Preassessment Screen for Natural Resources Damages is conducted to determine if additional action is warranted. Five general criteria are evaluated during a Preassessment Screen to determine if the NRDA should proceed. These five general criteria include:

- A release of oil or a hazardous substance has occurred;
- Trust natural resources have been affected or potentially affected;
- The quantity or concentration of released substances was sufficient to cause adverse effects;
- The availability of data, at a reasonable cost, for conducting a damage assessment; and
- The sufficiency of response actions to cease injury.

The Preassessment Screen is a prerequisite to conducting a formal NRDA. Trustees must determine whether an injury has occurred and a pathway of exposure exists (USEPA, 1999c). The Preassessment Screen is technically similar to the problem formulation stage of an ecological risk assessment. The Conceptual Site Model (CSM) that is used for risk assessment is also useful for injury assessment.

2.2 Assessment Plan

Once a preassessment screen has determined that additional NRDA action is warranted, the process moves onto the development of a formal Assessment Plan. An Assessment Plan is developed to identify and evaluate the potential natural resource injuries. A "Type B" (site specific) Assessment Plan may be developed, if appropriate to describe the site-specific studies to be conducted at the Site, including the supporting quality assurance/quality control procedures.

2.3 Assessment Implementation

Following the review and approval of the Assessment Plan, the Assessment Implementation is initiated. The purpose of the Assessment Implementation phase is to gather the data necessary to quantify the injuries and determine damages. The work consists of three steps:

(1) Injury determination;

(2) Injury quantification; and

(3) Damage determination.

These steps are performed through laboratory and field studies.

2.3.1 Injury Determination

Natural resource injury is defined as "a measurable adverse change in chemical or physical quality of a natural resource resulting from exposure to a discharge of oil or release of a

hazardous substance" (43 CFR Part 11). Determination of natural resource injury requires the completion of three steps:

- Natural resource potentially injured must be clearly identified (e.g., surface water, groundwater, air, geologic, and biological resources);
- Exposure pathway to the natural resource must be demonstrated; and
- Selection of appropriate testing and sampling procedures must be made in order to determine injury.

If needed, the CSM from the Baseline Risk Assessment (BRA) may be used to complete the first two steps. The selection of assessment endpoints and measurement endpoints for the ecological risk assessment (ERA) may be used as a means to partially complete the third step. Risk is not interchangeable with injury, however, because risk is "the potential for an adverse effect to occur," while injury is "a measurable adverse change in quality", risk may be predicted, but injury must have already occurred. At this point in the analysis, the BRA and NRDA diverge, and will be addressed separately. Where possible, however, complementary approaches will be used to identify ecological risk and resource injury associated with the Site.

2.3.2 Injury Quantification

Once injury to natural resources has been documented, the amount, or quantity of adverse effects, is measured. Care must be taken to determine the amount of an adverse effect that is associated with the release of oil or a hazardous chemical. Adverse effects to Trust resources that are not associated with the release of oil or hazardous substances are not recoverable under NRDA. These adverse effects establish the baseline condition of Trust resources. *Baseline* has a very different meaning in NRDA than in the BRA. In the BRA, baseline refers to the post-demolition site conditions, in the absence of remediation. In the NRDA, baseline refers to the quality of Trust resources before the release of oil or hazardous substances.

The investigative methods used to quantify injury will depend on the natural resources under consideration, and the specific chemicals that have been released. However, general measures of resource quality will be used to support the Preassessment Screen (and subsequent Injury Quantification, if needed). These general measures of resource quality include:

- Index of Biotic Integrity (IBI) surveys that are based on fish communities;
- The evaluation of water quality based on the physical/chemical characteristics of surface waters;
- The evaluation of sediment quality based on sediment quality criteria;
- Floristic indices that are based on the vegetative communities; and
- Threatened and endangered species surveys.

The application of these methods in support of the NRDA for the Site are described in greater detail in Section 3.0.

2.3.3 Damage Determination

This phase will establish the appropriate compensation for the injured Trust resources. Damage determination is essentially a resource valuation. The definition of *damages* under

NRDA is the cost of restoration, rehabilitation, replacement, and/or acquisition of equivalent resources. The Damage Determination phase will support the Restoration and Compensation Determination Plan that will describe a reasonable number of alternatives for restoration, rehabilitation, replacement or acquisition. Several economic models are suitable for damage determination, including scaling primary and compensatory restoration. The Habitat Equivalency Analysis (HEA) Model is well suited for damage determinations that involve injured habitats. The HEA Model is the model we intend to utilize for damage determination for the Site.

Attributes of the HEA model include:

- The habitat (stream, marsh, swamp, floodplain forest, etc.) is the basis for the model;
- An ecological currency (discounted service-acre-years) is used instead of a monetary currency (dollars);
- Active uses (hunting, fishing birding, etc.) and passive use values (existence, bequest) are inherently considered;
- Within the same habitat, compensation is "in-kind;" and
- The model output is the acreage of habitat to restore, rehabilitate, replace or acquire.

Because the habitat surrounding the slag pile is comprised of floodplain forest, emergent wetland and a river/stream complex, the HEA model is anticipated to be a very useful damage determination tool for the Site and Study Area.

2.3.4 Primary Versus Compensatory Restoration

Restoration actions under the NRDA process are either primary or compensatory. Primary restoration is action taken to return injured natural resources and services to baseline, including natural recovery. Compensatory restoration is action taken to compensate for the "interim loses" of natural resources and/or services pending recovery. Each restoration alternative considered will contain primary and/or compensatory restoration actions that address one or more specific injuries associated with a release. The type and scale of compensatory restoration will depend on the nature of the response activity and additional direct restoration (e.g. plantings), if any, to the injured resources.

Response activity and direct restoration have very gray boundaries as to where one process stops and the other takes over. Generally it is defined through agency authority more so than the activity. For instance, if an agency (i.e. U.S. Coast Guard, USEPA) determines source control from a release or the associated clean-up levels resulting from the release to be sufficient for purposes of protecting "human health and the environment", then response activity will be concluded. If Trust agencies have additional concerns over sources of contamination that may persist and prevent natural resource services from returning to baseline conditions, then they may undertake residual source control as direct restoration if the effort is not "grossly disproportionate" to the benefit. Additionally, if source control is not a concern, then other direct enhancements are part of the primary restoration plan. These primary activities are directly associated with the compensatory compensation in that direct enhancements speed the time frame of natural recovery to baseline conditions, thereby reducing the amount of compensatory compensation owed.

For the purposes of this Plan, the MDNR and the USFWS are the Natural Resource Trustees for this investigation.

2.3.5 Prohibition of Double-Counting

Trust agencies are statutorily prohibited from recovering for the same resource or services twice (15 CFR Part 990.22). Such duplicate recovery is called "double-counting." The double-counting issue can arise when Trustees have joint authority over resources such as migratory fish or wildlife, or when damages are calculated using two or more different methodologies.

2.4 Post-Assessment

The Post-Assessment Phase of NRDA involves documenting the results of the assessment, and proposing restoration alternatives. These steps are typically completed by the development of a *Restoration and Compensation Determination Plan.* This plan undergoes a public comment period and, pending acceptance, is implemented. Also included in the Post-Assessment phase are monitoring of primary and compensatory restoration activities.

3 Proposed NRDA for the Site

A primary means of conducting the Preassessment Screen will be to construct a CSM that evaluates:

- Sources of oil or hazardous substances;
- Pathways by which oil or hazardous substances are transported; and
- Trust resources that are potentially exposed to oil or hazardous substances in amounts or concentrations sufficient to cause adverse effects.

The CSM will be modified, as needed, to support this Preassessment Screen. To facilitate the Preassessment Screen, the CSM will also include:

- A detailed habitat map;
- Summaries of the biological integrity (baseline conditions) of the potentially-exposed habitats; and
- The results of a threatened and endangered species survey for each habitat.

In anticipation that an Injury Determination might need to be conducted, a field program will also use ecological metrics to estimate the baseline condition of potentially exposed and reference habitats in the lower Joachim Creek basin. As discussed above, the term "baseline" refers to "the condition of the natural resources and services that would have existed had the incident not occurred." These metrics will be measured during the Preassessment Screen to support the development of the CSM, and to support future injury quantification, if needed.

The scope of subsequent NRDA phases cannot be determined until the Preassessment Screen has been completed, but will fulfill the requirements discussed above.

3.1 Identification of Potentially-Exposed Habitats & Resources

Habitats and resources that could potentially be exposed to oil or hazardous substances released from the Site will be identified from field surveys, media sampling and field observations. While on a site visit during the week of November 6, 2000, ELM Consulting L.L.C. (ELM) personnel identified three habitat types adjacent to or near the slag pile:

- Floodplain Forest (Mesic; Wet-Mesic; or Wet);
- Wetlands (emergent marsh/scrub-shrub); and
- River/Streams (Joachim Creek).

A site visit and review of aerial photographs have showed that successional stages of floodplain forest are present adjacent to the Site to the west, south and east between the Site and Joachim Creek (Figure 5). In addition, emergent marsh habitat is located immediately south of the Site. This emergent marsh includes the former borrow pit which is currently dominated by willow (*Salix* sp.) trees (Figure 5). Located to the east, south and west of floodplain forest is Joachim Creek. Herculaneum, Missouri is on the east side of the state and this would represent the lower end of Joachim Creek. The confluence of Joachim Creek and the Mississippi River is located less than one mile downstream of the Site.

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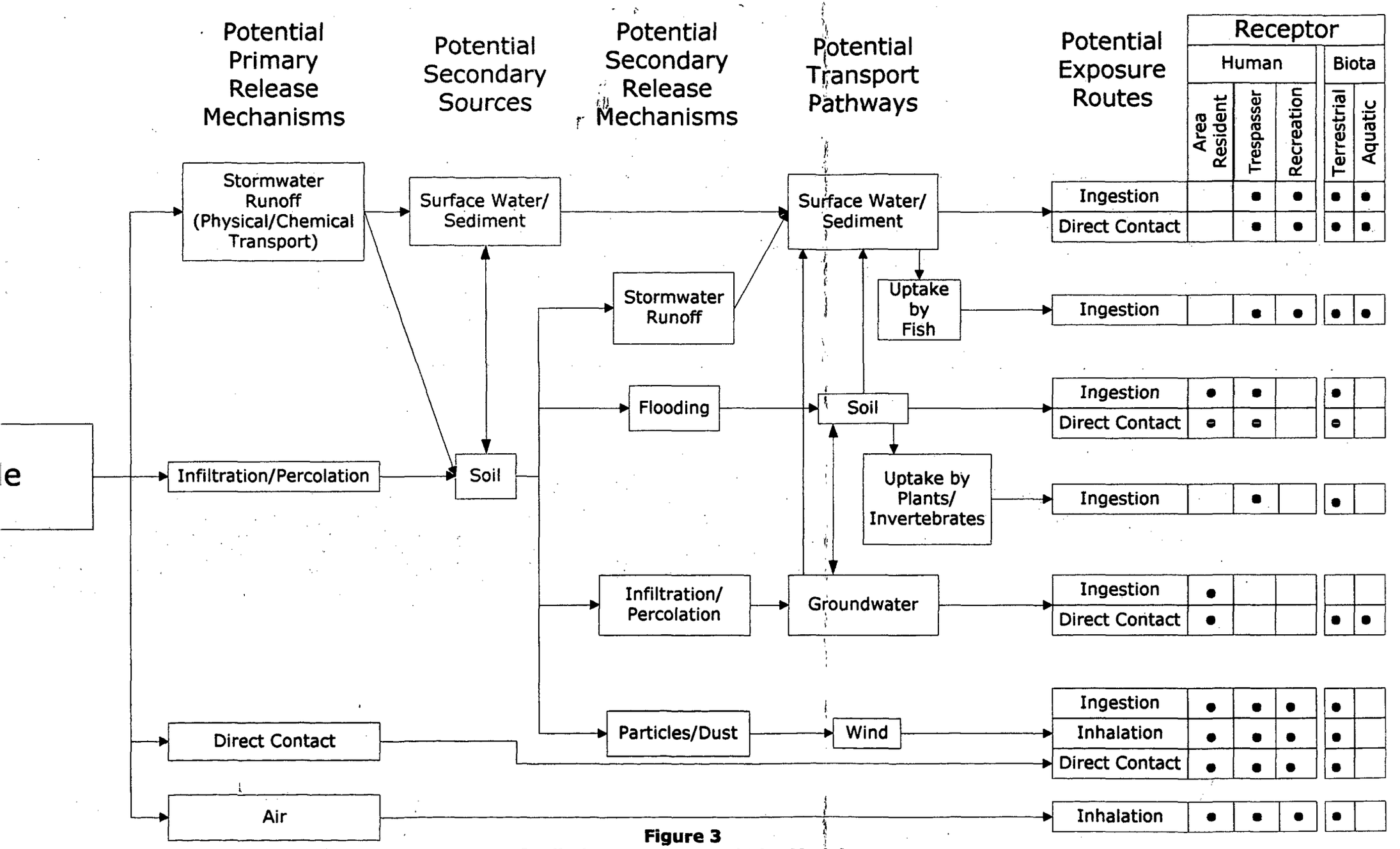

Figure 3
Preliminary Conceptual Site Model
Slag Pile Investigation
The Doe Run Company Lead Smelter-Herculaneum, Missouri

Initial investigations of the Joachim Creek watershed will emphasize the areas adjacent to the Site for the purpose of assembling the CSM. Evaluations of the baseline conditions will cover the area from the dam on Joachim Creek, located to the west of the Site, to the confluence of Joachim Creek and the Mississippi River (Figure 1). These are the habitats most likely to have received potential releases from the Site. If the results of these investigations indicate that releases were transported outside of this area, additional fieldwork will be conducted in subsequent phases of the investigation to establish the boundaries of the exposed area. Reference habitats will also be investigated in an area upstream of the Site.

A combination of chemical analyses and biological metrics will be used to determine baseline conditions in the habitats adjacent the Site. In addition, data from previous studies on the lower portion of the Joachim Creek watershed may be utilized. The same environmental media (surface water, surface soil, and surface sediments) and chemical analyses (heavy metals) will be used to support the BRA and NRDA. These sampling and analysis procedures are discussed in the SAP and the QAPP associated with this Plan. Depending on the results, additional sampling and chemical analyses may be conducted in subsequent phases. If appropriate, tissue samples may be collected, population studies may be conducted, or laboratory bioassays may be performed, where reasonable. Field sampling procedures to support the calculation of ecological indices are habitat-specific, and are discussed below.

3.1.1 Baseline for Joachim Creek Habitat

Ecological indices for aquatic habitats are typically based on water chemistry, macroinvertebrate communities or fish communities. Water quality indices are usually used to determine if a particular water body has potential to support biological organisms or a public water supply. The macroinvertebrate and fish indices typically are used to evaluate the degree of impairment in a water body. The Macroinvertebrate Biotic Index (MBI) and the Index of Biotic Integrity (IBI) are two examples. Because both the MBI and the IBI evaluate the degree of impairment to a water body, their applicability would be useful during the NRDA process. However, because of the lack of habitat for benthic invertebrates (root mats, fallen trees, logs, undercut banks, etc) and the dynamic sandy substrate at the lower end of the Joachim Creek, it is the opinion of ELM biologists that a MBI conducted in this particular stretch of the creek would not yield sufficient quantifiable data to compare reference and study reaches. Therefore, no MBI will be conducted. It is believed that a IBI conducted on Joachim Creek using applicable Missouri and Illinois Environmental Protection Agency (IEPA) protocols or area specific methodologies (i.e., backpack shocking or boat shocking specific habitats using consistent manpower and time limits) using IBI techniques would yield comparable data between any chosen study or reference reach. The decision as how to best apply these methodologies will be made in the field by experienced fisheries biologists during low flow conditions. The decision to choose a particular reference or study reach is strictly based on habitat comparability of the two reaches. Ideally, the creek will exhibit low flow conditions to properly evaluate the habitat of the potential reach and the surrounding area.

3.1.1.1 Index of Biotic Integrity

Ecological indices for aquatic habitats are typically based on water chemistry, macroinvertebrate communities or fish communities. Water quality indices are usually used to determine if a particular water body has potential to support biological organisms or a public water supply. The macroinvertebrate and fish indices typically are used to evaluate the degree of impairment in a water body. Because both the MBI and the IBI evaluate the degree of impairment to a water body, their applicability would be useful during Phase I of the Natural

Resource Damage Assessment process. It is believed that a IBI conducted on Joachim Creek or area specific methodologies (i.e., backpack shocking or boat shocking specific habitats using consistent manpower and time limits) using IBI techniques would yield comparable data between any chosen study or reference reach. The decision to how to apply the IBI protocols will be made in the field by experienced fisheries biologists during low flow conditions. The decision to choose a particular reference or study reach is strictly based on habitat comparability of the two reaches. The river must be at low flow conditions and with a low water height to properly evaluate the habit of the potential reach and the surrounding area.

Currently, the MDC and the MDNR are developing Missouri-specific fish sampling methods. The sampling techniques under development evolved from a statewide bioassessment program that would establish a baseline of current conditions of Missouri's aquatic resources and allow the MDC to determine the effectiveness of the management programs and seriousness of environmental threats. As a result of the need to establish this "baseline of current conditions", the concept of Resource Assessment and Monitoring (RAM) was conceived. To achieve RAM goals and objectives, the MDC, along with the MDNR, developed a draft *Standard Operating Procedure* manual for the fish-sampling component of MDC's RAM program. Because the MDC manual is in draft form during the writing of this SAP, general IBI protocols are proposed as described in the *Quality Assurance Project Plan-Integrated Water Monitoring Program Document* (IEPA, 1994). Methods described in the MDC manual will be employed where applicable.

The use of reference sites is essential to determining biotic health. Reference sites will be selected to represent the best attainable habitat, water quality and biological parameters (or reference conditions) of a sampling strata (i.e., region, ecoregion). The characteristics of reference sites will vary among sampling strata and stream order. Reference sites/conditions must be selected with care because they establish the basis for making comparisons and for detecting use impairment. The overall goal in the characterization of the reference condition is to describe the biota that are optimal for the region and type of waterbody of interest (MDC, 2001). To date, a characterization of Joachim Creek, it's watershed and tributaries and the Herculaneum area (from a surface water resource perspective) has not been conducted. Prior to the sampling of fish, a thorough characterization of a potential reference area will be completed. Data gathering techniques, such as the Stream Habitat Assessment Procedure and the water quality/physical characterization procedure (Section 5.1.1) will be utilized to make reference reach and study reach comparisons.

Fish occupy upper levels of aquatic food chains and are directly and indirectly affected by chemical and physical changes in the environment. Water quality conditions that significantly affect lower levels of the food chain will also affect the abundance, species composition, and condition of the fish community. While use of aquatic macroinvertebrates and water chemistry are integral components in the assessment of water quality and documentation of constituents causing impairment, the condition of the fishery is the most meaningful index of water quality to the general public. In recent years the MDC has placed greater emphasis on fish communities as indicators of stream quality. Consequently, the IBI is a suitable metric for establishing the baseline condition of Joachim Creek, and is proposed to be used as an assessment tool during the slag pile storage area investigation.

To determine baseline conditions of Joachim Creek, one reference reach upstream of the slag pile will be selected. Also, a study reach will be selected adjacent to or downstream of the slag pile. The selection process will involve habitat suitability, habitat comparability, and best professional judgment. The reference reach must mimic the study reach regarding habitat as much as possible. Habitat, whether it contributes to improved biotic integrity or lessens the biotic potential of the reach, should not play a factor in IBI scores. To insure that both the reference reach and study reach are similar in terms of habitat, Qualitative Stream Habitat Assessment Procedures (SHAPs) will be implemented as described in #99-0034-SOP-07 in

Appendix A of the SAP. The IBI will not commence until both reaches have been deemed similar, regarding habitat, using SHAPs. Exact locations of biotic sampling for the IBI will be made in the field prior to sampling. If a reference reach cannot be found that directly compares to the study reach or vice versa, then spot sampling of representative habitat may be the selected course of action. In this scenario, the same level of effort (manpower and manhours) will be applied to the reference reach and the study reach. This judgment will also be made in the field by an experienced fisheries biologist. Biological sampling will take place using backpack electrofishing techniques in areas that are wadeable. Also, to obtain quantitative data in reaches of Joachim Creek that are too deep to wade, a boat electrofishing techniques may be used in the field to collect fish. Guidance from the MDNR will be solicited to maintain consistency, and if feasible, an MDNR biologist will accompany the field sampling crew. For the complete sampling methodology for the IBI, refer to #99-0034-SOP-06 in Appendix A of the SAP.

3.1.1.2 Habitat Evaluation and Water Quality/Physical Characterization Assessments

To insure that the reference reach is comparable to the study reach with regard to habitat similarity, SHAPs will be conducted in the field prior to biological sampling. SHAPs are a qualitative approach to evaluate lotic habitat quality using features considered important to biotic integrity. SHAPs facilitate an assessment of stream quality predicted on 15 metrics associated with bottom substrate type, channel morphology, hydrology, and riparian features. Each metric is subjectively assessed and assigned to one of four habitat quality categories. The total possible score for each metric can range from a high of 20 for bottom substrate, to eight for channel sinuosity and top-of-bank land use. The total score of the stream reach assessed forms the basis of the overall habitat quality rating for the stream and can be used as a tool for biocriteria assessments when evaluating the relationship of habitat quality to biotic integrity (IEPA, 1994). For a detailed explanation of SHAPs and associated field data sheets, refer to #99-0034-SOP-07 in Appendix A of the SAP.

Each reach will be scored using SHAPs outlined in IEPA, 1994. The score of the reference reach will be compared to the score of the study reach. The following table summarizes the similarity categories for site comparability assessments:

Table 3-1. Stream Habitat Percent Similarity Categories for Site Comparability Assessments.

HABITAT QUALITY CATEGORY	PERCENT SIMILARITY
Excellent (Very Similar to Reference)	$\geq$ 90%
Good (Slightly Different)	75-89%
Fair (Moderately Different)	60-74%
Poor (Substantially Different)	$\leq$ 59%

The reference reach and the study reach must have a percent similarity of 75% or greater to be utilized during the IBI. If this threshold is not reached with the reaches selected, then another reach will be chosen and SHAPs will be re-applied.

In addition to SHAPs, water quality data, physical characterization activities and habitat quality information will be collected in the area of the sampling reaches.

The presence of an altered habitat structure is considered one of the major stressors of aquatic systems. The presence of a degraded habitat can sometimes obscure investigations on the effects of toxicity and/or pollution. The assessments performed by many water resource agencies include a general description of the site, a physical characterization and

water quality assessment, and a visual assessment of instream and riparian habitat quality. Together these data provide an integrated picture of several of the factors influencing the biological condition of a stream system (Barbour et. al., 1999).

The combination of physical characterization and water quality will provide insight as to the ability of the stream to support a healthy aquatic community, and to the presence of chemical and non-chemical stressors to the stream ecosystem (Barbour et. al., 1999). The following table describes what information is obtained during physical characterization/water quality collection activities.

Table 3-2. Components to Physical Characterization/Water Quality Collection Activities Associated with Biological Sampling Reaches.

PARAMETER	DESCRIPTION OF PARAMETER
Header Information	Stream name and location, Investigators, Date, Time, etc.
Weather Conditions	Current, past 24 hours, air temperature.
Site Location/Map	Drawing of sampling reach and specific sample locations.
Stream Characterization	Subsystem, origin, type, catchment area
Watershed Features	Predominant Surrounding Landuse, local watershed NPS pollution, local watershed erosion.
Riparian Vegetation	Dominant type and dominant species present
Large Woody Debris (LWD)	LWD in m^2, Density of LWD m^2/km^2
Aquatic Vegetation	Dominant type and dominant species present
Water Quality	Temperature, specific conductance, dissolved oxygen, pH, turbidity, instruments used, water odors, presence of surface oils
Sediment/Substrate	Odors, oils, deposits
Inorganic Substrate Components	Substrate type and percent composition in the sampling reach
Organic Substrate Components	Substrate type and percent composition in the sampling reach

The habitat quality evaluation can be accomplished by characterizing selected physicochemical parameters in conjunction with a systematic assessment of physical structure. Through this approach, key features can be rated or scored to provide a useful assessment of habitat quality (Barbour et. al., 1999). The following table describes what information is obtained during habitat assessment activities.

Table 3-3. Components to Habitat Assessment Activities Associated with Biological Sampling Reaches.

HABITAT PARAMETER	DESCRIPTION
Epifaunal Substrate/Available Cover	Includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofanua.
Pool Substrate Characterization	Evaluates the type and condition of bottom substrates found in pools.
Pool Variability	Rates the overall mixture of pool types found in streams, according to size and depth.
Sediment Deposition	Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition.
Channel Flow Status	The degree to which the channel is filled with water.

Channel Alteration	Measure of large-scale changes in the shape of the stream channel.
Channel Sinuosity	Evaluates the meandering or sinuosity of the stream.
Bank Stability	Measures whether the stream banks are eroded (or have the potential for erosion).
Vegetative Protection	Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone.
Riparian Vegetation Zone Width	Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone.

Complete protocols for the Physical Characterization/Water Quality evaluation and Habitat Assessment for biological sampling are found in #99-0034-SOP-08 in Appendix A of the SAP.

3.1.1.3 Additional Biological Surveys

Decisions to conduct additional biological surveys, such as reptile, amphibian, bird and mammal evaluations, will be made on an as-needed basis. Information as to the documentation of threatened and endangered species of these classes of organisms as well as suitable habitat for these organisms within the Study Area or in areas surrounding the Site can be obtained while habitat characterizations are being conducted under the Preassessment Screen of the NRDA.

3.1.2 Baseline Conditions of Floodplain Forest and Wetland Habitats

Terrestrial habitats on and surrounding the Site include: successional floodplain forest, scrub-shrub wetland and emergent marsh wetland (Figure 5). These habitats were identified by ELM personnel during a site visit in November, 2000. Ecological indices of these habitats are typically based on floristic studies. Estimates of floral richness are useful for determining the distribution of plants within a community and are often used to monitor changes in plant communities over temporal and spatial scales. Estimates of floral density are necessary for determining species abundance. For these habitats adjacent to the Site, a combination of transects and plots will be used to estimate vegetative community composition.

Technical advice may be solicited from MDNR and/or Missouri Department of Conservation (MDOC) for assistance with plant identification and data analysis. If feasible, an MDNR/MDOC botanist will accompany the field crew during the floristic surveys. Further, floristic surveys may be conducted in two different seasons at the same plot locations to ensure accurate plant identification. Additionally, threatened and endangered species surveys will be conducted to determine the presence of listed flora within these habitats.

3.1.2.1 Quantitative Floristic Community Survey

To aid in determining baseline conditions of the Study Area as well as determine potential exposure of natural resources to COPCs, a quantitative floristic community survey will be performed. During a site visit by ELM in November of 2000, four habitat types were observed in the area of the Site. These included:

- Mature floodplain forest;
- Successional floodplain forest;
- Emergent wetland; and
- Scrub-shrub wetland

Mature floodplain forest was located west, south and southeast of the slag pile across Joachim Creek. Additionally, a narrow corridor of mature floodplain forest remained along the riparian corridor of Joachim Creek immediately south of the slag pile (Figure 5). Large stands of silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*) Eastern sycamore (*Platanus occidentalis*), American elm *(Ulmus americana*) and box elder (*Acer negundo*) were observed in these areas during the site visit. Historical aerial photographs, particularly the 1966 and 1978 photographs (Appendix A), show heavy cultivation of the slag pile storage area before it was utilized as a waste management unit by Doe Run. However, this strip of mature floodplain forest remained and currently has mature trees very similar to the non-cultivated floodplain forest across Joachim Creek to the south.

Areas of the floodplain that were cultivated in the 1950's and 1960's are currently in various stages of succession near the Site. The area between the slag pile and Joachim Creek, the "Future Waste Management Area" and areas across Joachim Creek east of the slag pile all show signs of succession (Figure 5). The canopy in these areas show the same tree species as that of the mature floodplain forest are but much less mature.

The two remaining habitat types have developed from the creation of the borrow pit southeast of the slag pile (Figure 5). The 1978 historical aerial photograph shows the borrow pit prior to being inundated with water (Appendix A). Adjacent to the slag pile is a large area of emergent wetland dominated by what appeared to be rice cutgrass (*Leersia oryzoides*). At the time of the site visit, the area was inundated to a depth of approximately six inches. To the southeast of the emergent wetland, a monotypic stand of willow (*Salix* sp.) was observed. This area was also inundated to a depth of six-ten inches.

In addition to historical aerial photographs, National Wetland Inventory (NWI) maps from the USFWS were reviewed and similar habitat designations were given to the areas under investigation (Appendix B).

The following table (Table 3-4) describes the NWI designations in the Study Area of the SPI.

Table 3-4. Summary of NWI Designations for Habitats within the Study Area.

HABITAT	LOCATION	USFWS DESIGNATIONS	EXPLANATION OF DESIGNATIONS
Mature Floodplain Forest	West, south and southeast of the slag pile; across Joachim Creek	PFO1C	Palustrine Forested Broad-Leaved Deciduous Seasonally Flooded
Successional Floodplain Forest	Northwest and east of the slag pile; across Joachim Creek	PFO1C	Palustrine Forested Broad-Leaved Deciduous Seasonally Flooded
Emergent Wetland/Scrub-Shrub Wetland	In former borrow pit area; southeast of the slag pile	P SS1 C EM	Palustrine Scrub-Shrub Broad-Leaved Deciduous Emergent Seasonally Flooded

As shown in Appendix B, the NWI map generally describes the current site conditions. Various site-specific conditions have changed due to historic and current land use. All current wetland habitat information will be added to Figure 4 once the quantitative floristic survey and wetland delineation are complete.

Because of the floristic community present in each of these habitat types, only the mature floodplain forest, the successional floodplain forest and the emergent wetland will be evaluated quantitatively. The scrub-shrub wetland (willow stand) will be qualitatively evaluated during the qualitative floristic community survey as described in Section 3.1.2.2. Because of the monotypic nature of the willow stand, a quantitative survey would yield little valuable information for such a level of effort. During the qualitative observations, a species list will be generated and the total acreage of the wetland will be estimated.

As shown on Figure 5, a total of 11 transects have been proposed to fully characterize each habitat type as well as obtain floristic measurements from reference locations. Two (2) transects have been established within the emergent wetland southeast of the slag pile. Quantitative data will be useful in this specific habitat to ascertain whether this area is in very early stages of succession. If saplings are present within this area and it is predicted that the emergent wetland will revert back to floodplain forest in the future, then this information will be very helpful during the development of potential restoration strategies during subsequent Phases of the SI. Three (3) transects have been proposed in successional floodplain forest between the slag pile and Joachim Creek. In conjunction with these three transects, two transects, which represent reference locations for successional floodplain forest, have been established east of the slag pile and across Joachim Creek (Figure 5). To evaluate mature floodplain forest, two (2) transects are proposed along the riparian corridor between the slag pile and Joachim Creek. In conjunction with these two transects, two transects, which represent reference locations for mature floodplain forest, have been established west of the slag pile, across Joachim Creek (Figure 5).

The use of reference transects will be crucial when comparing potentially impacted habitats with those that have not been influenced by the operation of the Site. The habitat information obtained during the review of historical aerial photographs (Appendix A) and the site visit in November, 2000 has lead to the transect location decision strategy (both investigative and reference). Exact locations will be established in the field by trained botanist prior to the survey. The following table (Table 3-5) summarizes the number and locations of the quantitative floristic survey transects:

Table 3-5. Number and Location of the Quantitative Floristic Survey Transects.

HABITAT TYPE	TYPE OF TRANSECT	NUMBER OF TRANSECTS	LOCATION OF TRANSECT
Mature Floodplain Forest	Investigative	2	Along the riparian corridor, south of the slag pile
	Reference	2	West of slag pile; across Joachim Creek
Successional Floodplain Forest	Investigative	3	South of the slag pile between the slag pile and Joachim Creek
	Reference	2	West of the slag pile; across Joachim Creek

Emergent Wetland	Investigative	2	In the former borrow pit area; southeast of the slag pile
	Reference	-	-

3.1.2.1.1 Quantitative Survey Metrics

Depending upon which floral community is present, the following habitat types (Table 3-6) will be sampled and the following sampling indices will be utilized to assess the plant assemblage:

Table 3-6. Habitat Types, Communities and Indices Associated with the Floristic Survey.

HABITAT TYPE	VEGETATIVE COMMUNITY	INDEX
Successional Floodplain Forest	Canopy, Subcanopy, Shrub, Herb Cover	Density, Basal Area, Cover, Herb Species Richness
Mature Floodplain Forest	Canopy, Subcanopy, Shrub, Herb Cover	Density, Basal Area, Cover, Herb Species Richness
Emergent Marsh Wetland	Shrub, Herb Cover	Density, Cover, Herb Species Richness

The metrics to be used will yield information as to the dominant species present within each habitat type. Each of the metrics are summarized below.

The various metrics to be utilized in the field to obtain quantifiable data include:

- Frequency;
- Density;
- Basal Area; and
- Herb Species Richness

Frequency is the percentage of the sample units in which a species occurs. If, for example, 50 small plots were examined in a study site and bitterbrush occurred in 20 of those plots, the frequency of bitterbrush would be 20/50 X 100, or 40%. Frequency is a simple attribute to estimate because the plant either occurs in the sample unit or it does not. Frequency is a useful characteristic for describing the distribution of plants within a community, and it is useful for monitoring changes in the plant community over time or comparing different communities.

Density is the total number of objects (e.g., individual plants, seeds) per unit area. One advantage of the density parameter is that count data are straightforward to obtain and interpret, and results obtained from various methods are directly comparable.

Stand basal area is a very useful parameter for quantifying a forest stand. It may be seen as a summary of the number and the size of trees in a stand.

Herb species richness will be calculated as number of species per plot or quadrat. The Daubenmire Cover Scale will be used to determine what percentage each species of plant is covering the area of the 1 m^2 quadrat.

3.1.2.1.2 Quantitative Survey Sampling Approach

The floristic survey will be performed with a random transect/plot/quadrat approach. The length of a main sampling transect will be determined by the size of the habitat being sampled. The maximum length of any main transect will be 100 meters. Four (4) "perpendicular transects" are randomly established perpendicular to the main transect. A 400 m^2 plot is then randomly positioned on the terminal ends of each of the perpendicular transects which yields a total of eight (8) 400 m^2 plots. Located within the center of each of the 400 m^2 plots are 40 m^2 subplots. Finally, five (5) 1 m^2 quadrats are randomly set within each quarter section of the 400 m^2 plot yielding 20-1 m^2 quadrats within each 400 m^2 plot. All perpendicular transects, 400 m^2 plots and 1 m^2 quadrats are randomly set within this survey model. A minimum of one (1) meter distance will be obtained between plots to avoid crossing plot boundaries. To attempt not to have any cross-community effects during sampling along the edges of two community types (i.e., a successional floodplain forest transitioning to an emergent wetland), the terminating points of each transect with remain five meters off of each ecotone. For a complete description of this quantitative floristic survey method, field data sheets and a diagram of the survey model, refer to #99-0034-SOP-09 in Appendix A of the SAP.

3.1.2.1.3 QC Procedures During the Quantitative Survey

As described in SOP #99-0034-SOP-09, no sampling will occur across natural community borders. For example, sampling locations will not cross from a successional floodplain forest to a mature floodplain forest as the floristic assemblage will be different from one natural community to another. Therefore, each sampling transect and plot will remain, at a minimum, five (5) meter off of the adjacent ecotone.

For this sampling methodology, two teams of two people will be conducting the survey. Each team will have an experienced botanist who will identify the plant species and conduct each metric described in Section 3.1.2.1.1. To insure that subjectivity is kept to a minimum during the calculation of herb species richness, the botanists will cross-check each other work by estimating the percentage of cover from the other team's quadrats at a frequency determined by the QA Manager. If differences in estimated cover, from one botanist to the other, are beyond QA/QC standards, the sampling crew will cease work and a review of the floristic survey methods will be conducted by Doe Run.

In the interest of cooperation, an agency (MDOC/MDNR) botanist will be asked to accompany the field crew during the survey to provide input and observe sampling methodology.

3.1.2.2 Qualitative Threatened and Endangered Plant Species Survey

As part of Phase I of the NRDA, a qualitative threatened and endangered plant species survey will be conducted within the Study Area. The results of the survey will aid in determining baseline conditions of the habitats surveyed as well as document sensitive areas that will be avoided if/when remedial activities occur.

According to a letter from the MDOC staff (Appendix C), there are no federally listed or state listed threatened or endangered plant species found in the Missouri Natural Heritage Database with specific regard to the lower Joachim Creek area or Herculaneum, Missouri. However, according to the MDOC, the Fremont's Leather Flower (*Clematis fremontii*), a "rare and uncommon plant in Missouri", has been identified approximately four miles west of the Site.

3.1.2.2.1 Qualitative Plant Survey Methodology

To perform the survey, a trained botanist, whose expertise includes state-listed plant species of Missouri as well as indicator species information and habitat preference, will become familiar with the Study Area through the observation of aerial photographs. A biologist with ELM will provide all necessary site background, history and habitat information required by the botanist. Additionally, the botanist will tour all major habitat types and areas of concern within the Site and Study Area to observe site-specific characteristics. Once the botanist is comfortable with the introduction to the Study Area, a ELM biologist and the botanist will determine areas of suitable habitat for the various threatened and endangered species that could potentially be found in the Study Area. When these strategic areas are determined, the ELM biologist and the botanist will perform the survey.

The survey will consist of visual observation by the botanist of all flora of a particular suitable habitat. The botanist will look for threatened and endangered species and indicator species that may show the potential of a threatened or endangered plant occurring in that area. Additionally, the botanist will look for suitable habitat where a state-listed species may occur. General floristic community observations will be documented on field data sheets. If a state-listed plant species is observed in the study area, the exact location will be documented and the area of the plant(s) will be flagged. The MDNR will immediately be notified as to the presence of the state-listed species as well as all parties involved with the NRDA and slag pile investigation process. The area where the plant(s) was observed will then be more extensively demarcated so that no evasive activities occur at or near the location of the plant(s). During the qualitative field survey, the botanist will complete a "Qualitative Floristic Survey-Field Data Sheet" (Appendix A of the SAP) to record all observations.

3.1.2.3 Wetland Habitats

On November 11, 2000, ELM contacted the regulatory branch of the United States Army Corps of Engineering (ACOE) that has jurisdiction over the Herculaneum, MO area to inquire about relevant wetland delineation information within the Study Area. On March 24, 1999, representatives from the ACOE established four data points along the Joachim Creek watershed for the purposes of delineating wetlands in the area (Appendix D). Three data points were located between Joachim Creek and the Site to the west (1-1), southwest (1-2) and south (1-3). A fourth data point was located west of Joachim Creek upstream of the slag pile (2-1). All four data point locations showed hydrophytic vegetation and wetland hydrology characteristics. No hydric soil information was made available to ELM.

As part of the NRDA, a wetland delineation will be performed within the Study Area where jurisdictional wetlands are suspected. The results of the survey will aid in determining baseline conditions of the habitats surveyed as well as show sensitive areas that will be avoided if/when remedial activities occur.

During a site visit conducted by ELM personnel in November, 2000, three habitat types where wetlands were suspected were observed adjacent to or near the Study Area. These areas included: (1) successional floodplain forest located south, west and east of the Site; (2) emergent marsh located adjacent to the Site to the south; and (3) scrub-shrub wetland in the area of the former borrow pit. Because wetland characteristics such as hydrophytic vegetation and inundation were identified in the study area, wetland delineation activities are warranted.

3.1.2.3.1 Wetland Delineation Activities

To determine wetland environments within the Study Area, a wetland delineation will be performed. The wetland delineation will encompass two separate tasks:

- Field Reconnaissance; and
- Wetland Delineation Summary Report

During the field reconnaissance, an investigation of the Study Area will be completed to determine the limits of the wetlands present. The wetland delineation will be completed based on the methodology established by the ACOE. Also during the site visit, wildlife and plant community qualities will be assessed. The limits of the wetland community will be field staked so that they can be located in relation to study areas boundaries currently present on existing study area maps.

The results of the field reconnaissance will be summarized in a report, including an exhibit depicting the approximate Study Area wetland boundaries. The report will be suitable for submittal to the ACOE as part of a Section 404-permit application if/when a wetland habitat is to be altered in any way. The wetlands' generalized quality ratings will be included along with exhibits depicting the approximate wetland and project boundaries. National Wetland Inventory maps, Soil Survey, floodplain, USGS topographic maps, site photographs and the ACOE Routine On-Site Data Forms will be included.

To quantify the exact wetland acreage and to determine precise location, all wetland boundaries should be surveyed under a separate task.

3.2 Deliverables

It is anticipated that the preassessment screen will be completed during Phase I of the SI. The preassessment screen will determine if additional damage assessment is warranted, based on the five general criteria described in Section 2.1 of this Plan. If the preassessment screen concludes that additional action is warranted, an Assessment Plan will be prepared for implementation in Phase II of the SI.

4 The Habitat Equivalency Concept

Because natural resources have potentially been impacted by the operation of the Site and the potential injuries will need to be scaled if such impacts have occurred, it is useful to briefly discuss the habitat equivalency concept at the outset to assure that the parties have the same understanding of the process. HEA is a habitat-based restoration approach that has received attention for its potential application in several types of environments. The HEA approach is based on the principal assumption that the public can be compensated for past losses in environmental services through the provision of additional services of the same type in the future. That is, once natural resource injuries are quantified and the resulting lost ecological services calculated (i.e., the "debit"), the amount of lost services can be used as the basis for developing and evaluating the types and amounts of restoration (i.e., the "credit") necessary to compensate for forgone ecological services. In this case, both the "debit" and "credit" are evaluated using a definable "ecological metric", rather than dollars. As the name implies, habitats or habitat equivalents are the appropriate units of measure for conducting a Habitat Equivalency Analysis (NOAA, 1997). Since injury levels drive the restoration process, HEA is used as a tool to scale the level of restoration to the actual injury (loss of ecological and related recreational services) that has occurred. This is advantageous in that those species/habitats/services that suffered losses as a result of a release(s) are most likely to benefit from the damage award (i.e., restoration).

HEA is fundamentally an accounting process. In this process, the loss of ecological services resulting from release-related natural resource injuries is evaluated to determine how many acres of an equivalent habitat are required to compensate or repay the public for the lost ecological services (e.g., how many acres of a habitat must be restored in order to fully compensate for the habitat services injured by the releases.)

4.1 How the HEA Process is Used in Assessing Natural Resource Damage Claims

The basic HEA process consists of two distinct phases. Phase I involves the calculation of interim lost services, or "debit," for each of the affected habitats. Interim lost services consist of the discounted sum of lost or reduced ecological services from the time of initial injury until recovery of services to baseline levels. The "debit," measured in units of discounted service-acre-years (dSAYs), is illustrated by area "A" in the generic example shown as Figure 6. The parameters used by the model to calculate the "debit" term include:

- Affected acreage (by habitat);
- Lost ecological services (percent injury);
- Number of years to full recovery (of the injured services);
- Shape of recovery curves (linear, exponential, spline); and,
- Real annual discount rate.

Phase 2 involves the calculation of "credits." HEA "credits" are gained through the provision of additional ecological and related recreational services through the creation/protection of similar habitat(s), rehabilitation or enhancement of the injured habitat(s), acquisition of the equivalent habitat(s), or a combination thereof. The "credit" area can be viewed as area "B" in either Figure 7 (generic habitat creation/acquisition) or Figure 8 (generic habitat rehabilitation/enhancement). The parameters which are used by the model to calculate the "credit" portion of the model include:

- Elapsed time to restoration startup (due to permitting, planning, settlement);
- Relative productivity of created/acquired habitat versus natural habitat and/or relative productivity of rehabilitated habitat versus natural baseline condition;

- Years to full service flow after creation, acquisition or rehabilitation;
- Shape of the project functional performance curve (linear, exponential, spline);
- Lifespan of the created, acquired or rehabilitated habitat; and
- *Real annual discount rate.*

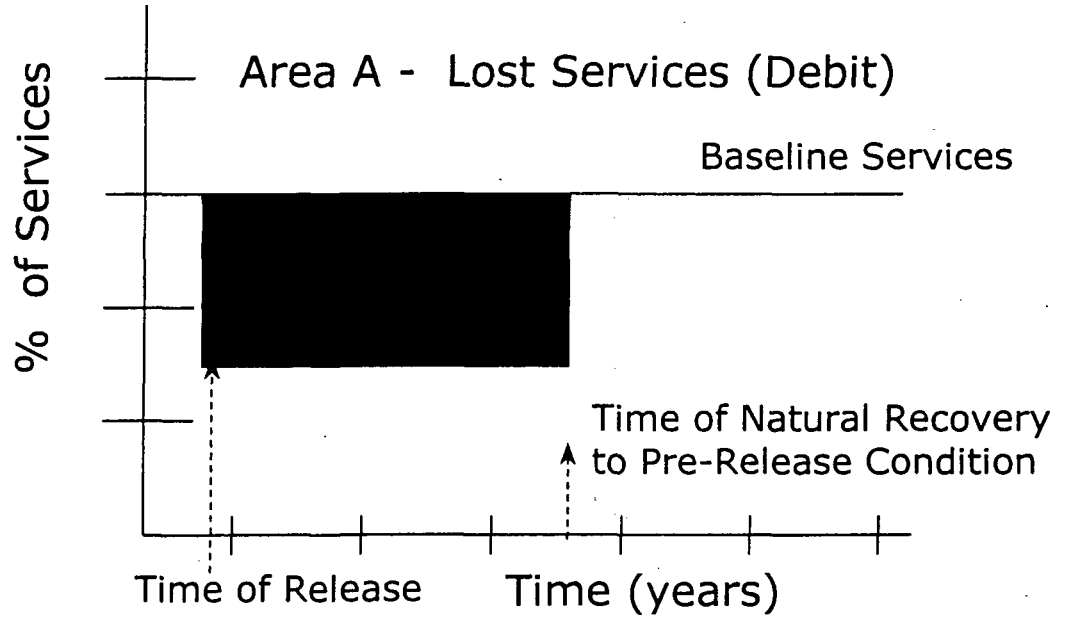

Figure 6. Conceptual view of the interim lost ecological services (debit) that are accrued from injury to a habitat.

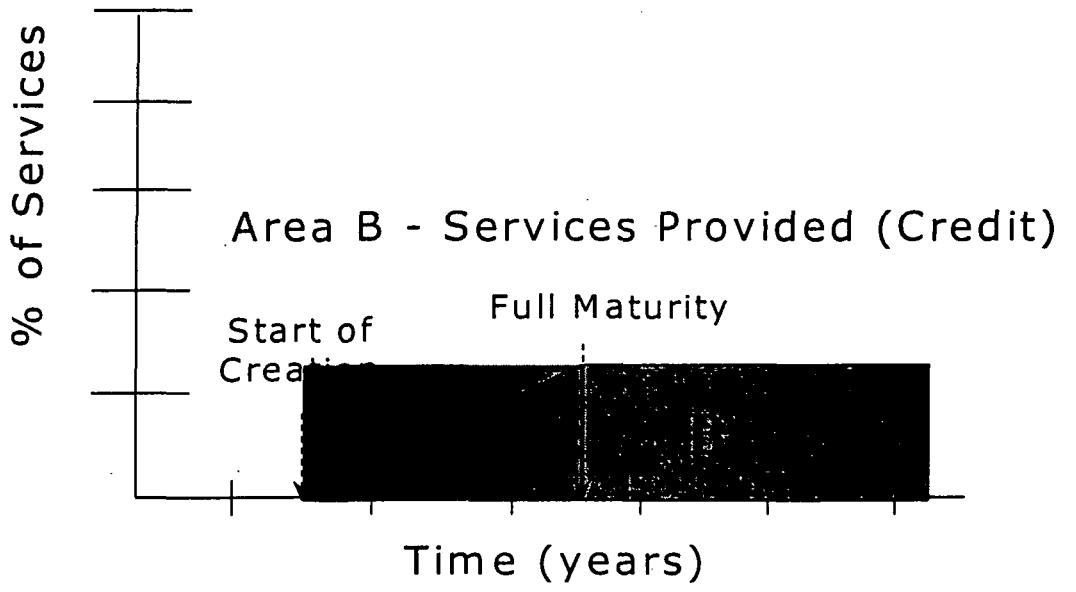

Figure 7. Conceptual view of ecological services that are gained (credit) through creation of acquisition of a habitat.

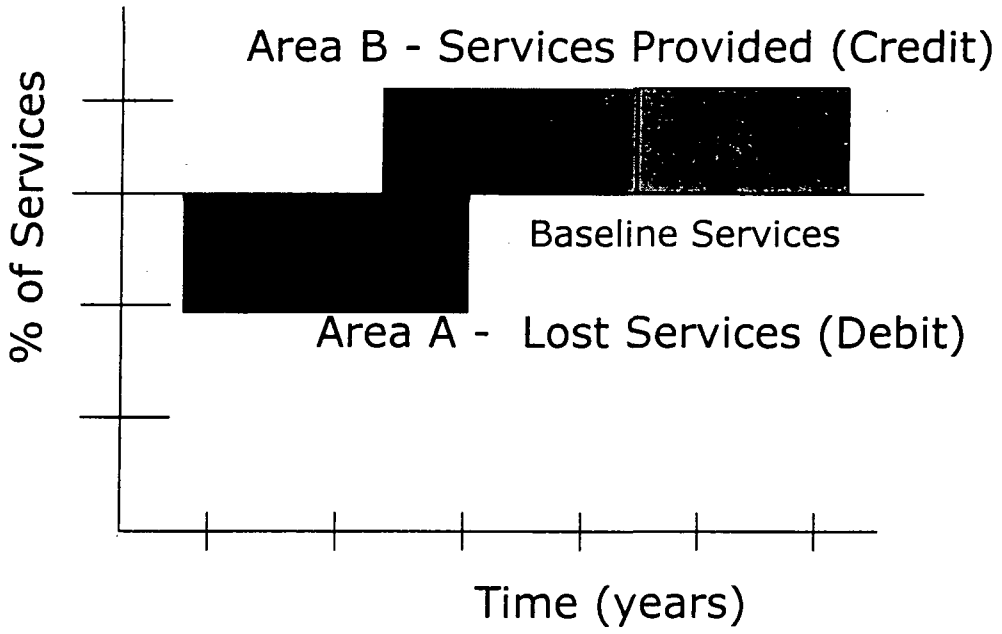

Figure 8. Conceptual view of ecological services debit (area A) and credit (area B). The public has been fully compensated (made whole) when area B equals area A. In this example, ecological services (credit) are gained through habitat rehabilitation/enhancement.

The ultimate goal of HEA is to scale the amount of restoration to the magnitude of the injury. To achieve this goal, the HEA model calculates the amount of restoration (in acres or in discounted service acre years) necessary so that the ecological service flows arising from the habitat creation, rehabilitation, or acquisition (area "B") are equivalent to the interim lost services which would have been provided by the habitat had the releases not occurred (area "A"). Since the HEA "credit" parameters are project/site-specific, the amount of restoration needed is dependent upon the restoration option(s) selected.

4.2 Discounting and the Discount Rate

Discounting operates in the reverse direction of compounding. While compounding measures how much present day investments will be worth in the future, discounting measures how much future benefits are worth today. An example of compounding interest of which most people are familiar, shows $100 invested today at 6 percent interest will be worth $106 in a year. In two years the gains will be earned on not just the initial $100 but the added $6 as well so that the gains in the second year will be $6.36. At 6% interest, the $100 investment will be worth about $200 in twelve years, $400 in twenty four years and almost $34,000 in a hundred years. Discounting operates in the opposite direction. Discounting measures how much future benefits are worth today. To calculate the present value, we must choose a discount rate to transform benefits a year from now into benefits today. If we choose the same discount rate as the interest rate used in the compounding example above (6%), $106 a year from now would be equal in value to a $100 today.

The discount rate is used to measure how much the public values future (or past) ecological services today. For our purposes here, the discount rate is used to calculate how much the flow of lost services from 1997 into the future are valued in terms of the present-day (i.e., 1999) currency. Similarly, the discount rate is used to find how much the flow of restoration services from 1999 into the future are valued in terms of present-day currency. The use of a discount rate allows debits and credits to be compared directly as net present values. In other terms, the discount rate is used to account for the time value of ecological services, which are a form of biological currency. We have also used the 3% real discount rate used (15 CFR 990).

5 Literature Cited

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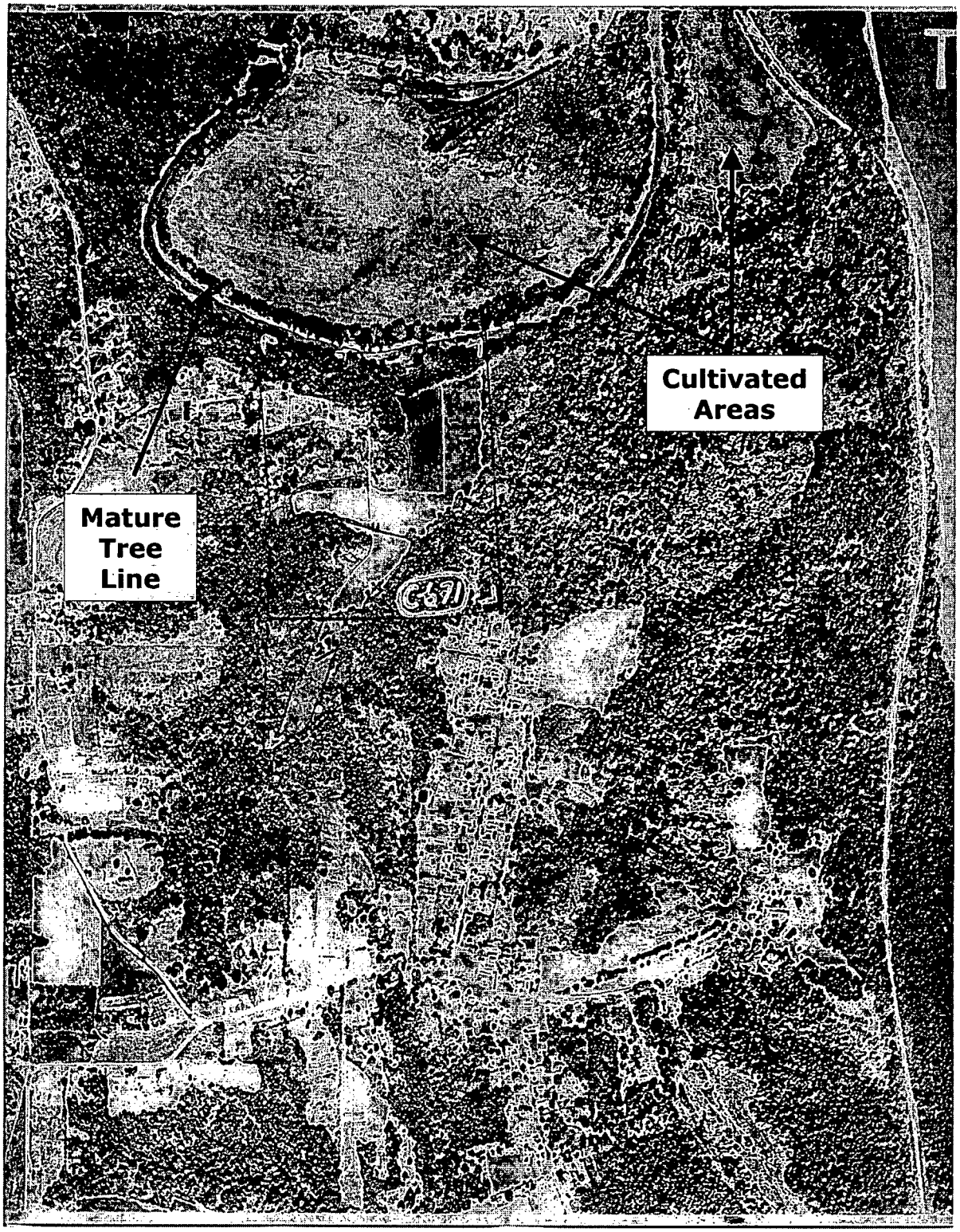
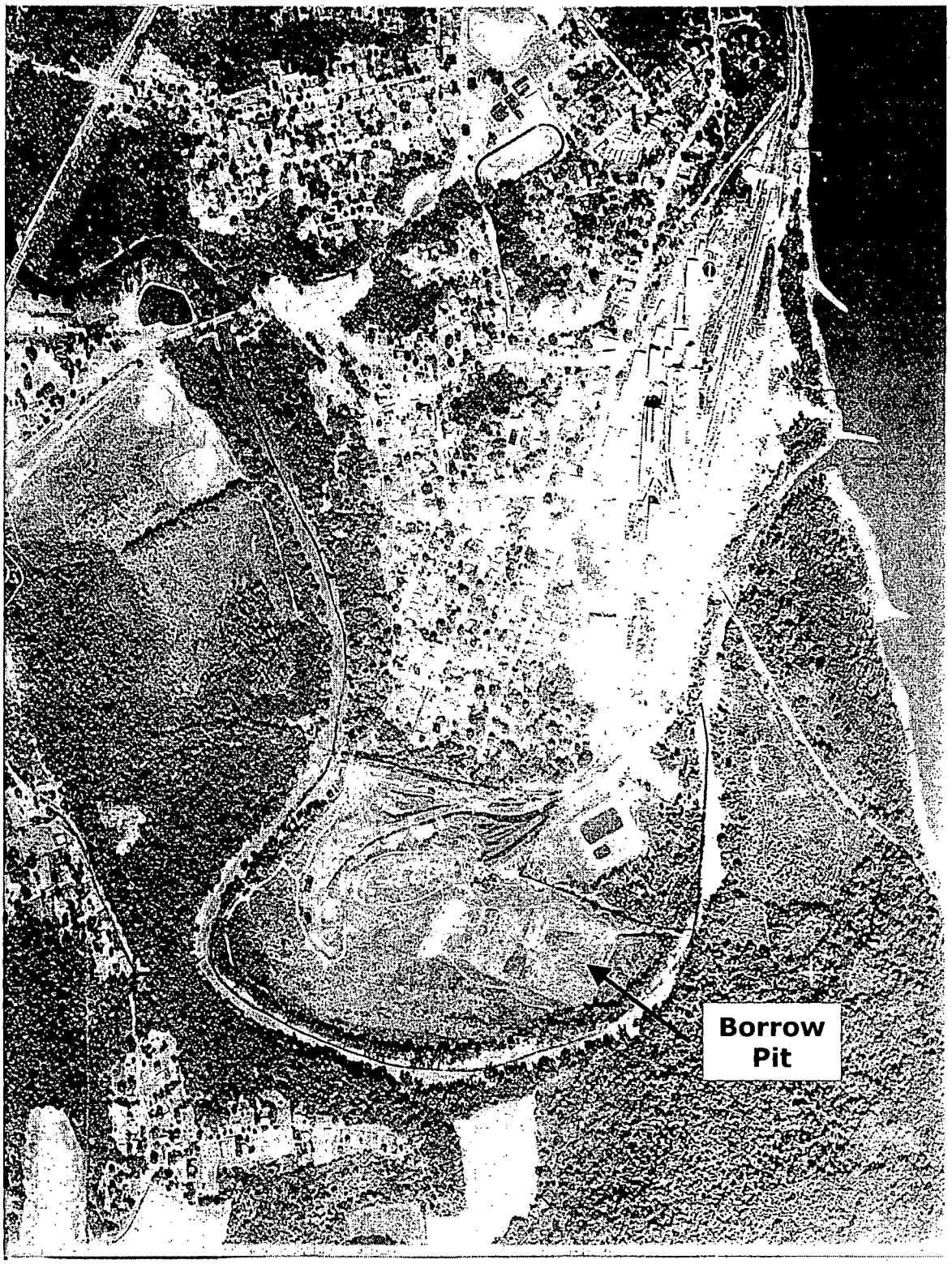
APPENDIX A
HISTORICAL AERIAL PHOTOGRAPHS

- 1966 PHOTOGRAPH;
- 1978 PHOTOGRAPH;
- 1993 PHOTOGRAPH



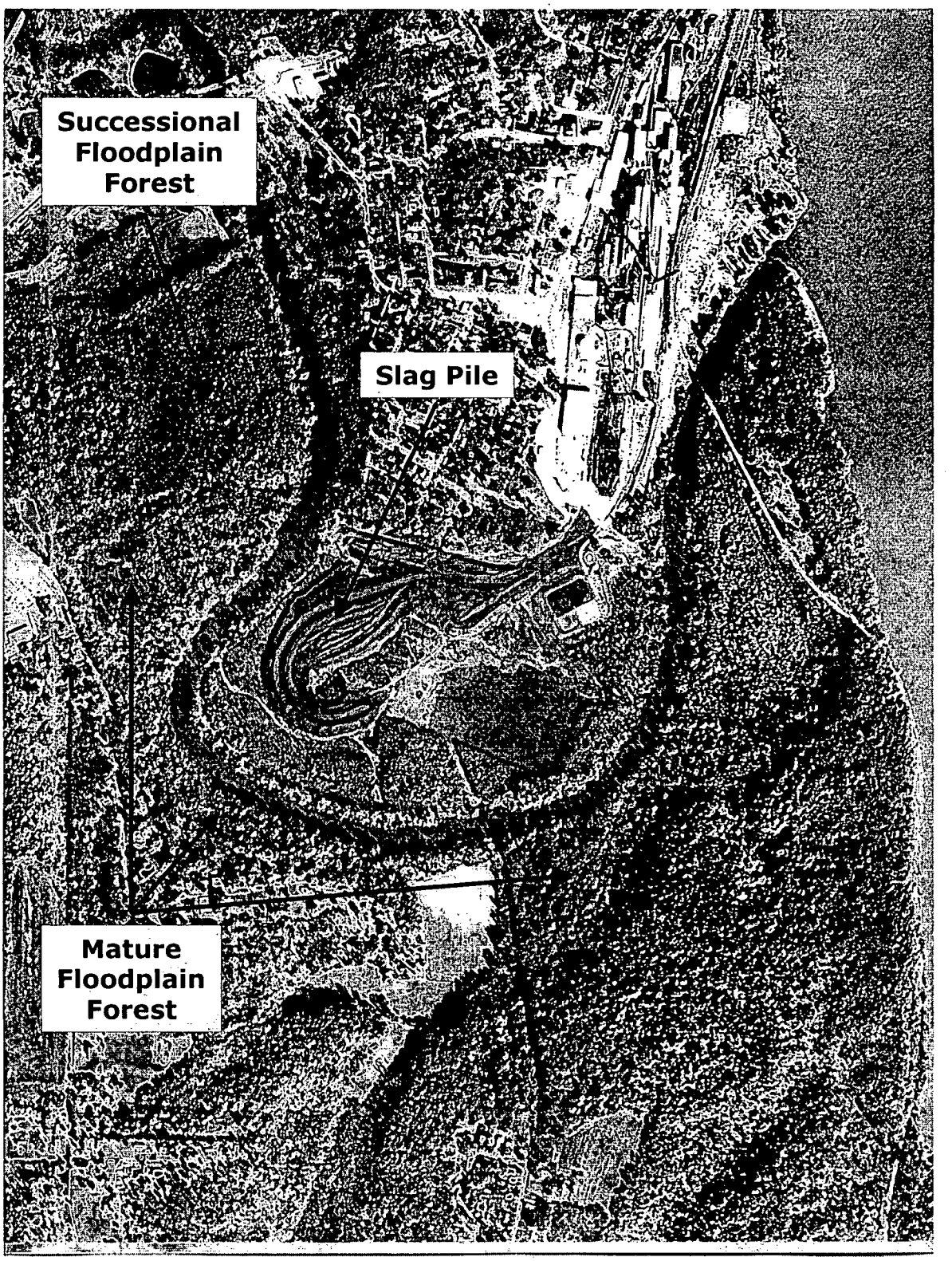
Slag Investigation
Historical Aerial Photograph
1966

Photograph obtained from the Jefferson County Soil & Water Conservation District



Slag Investigation
Historical Aerial Photograph
1978

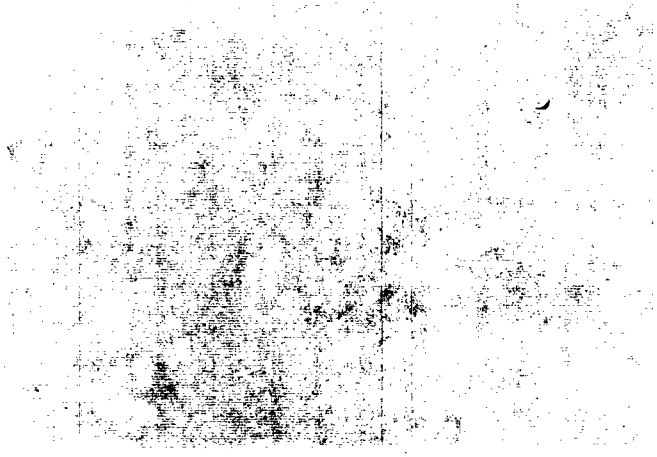
Photograph obtained from the Jefferson County Soil & Water Conservation District

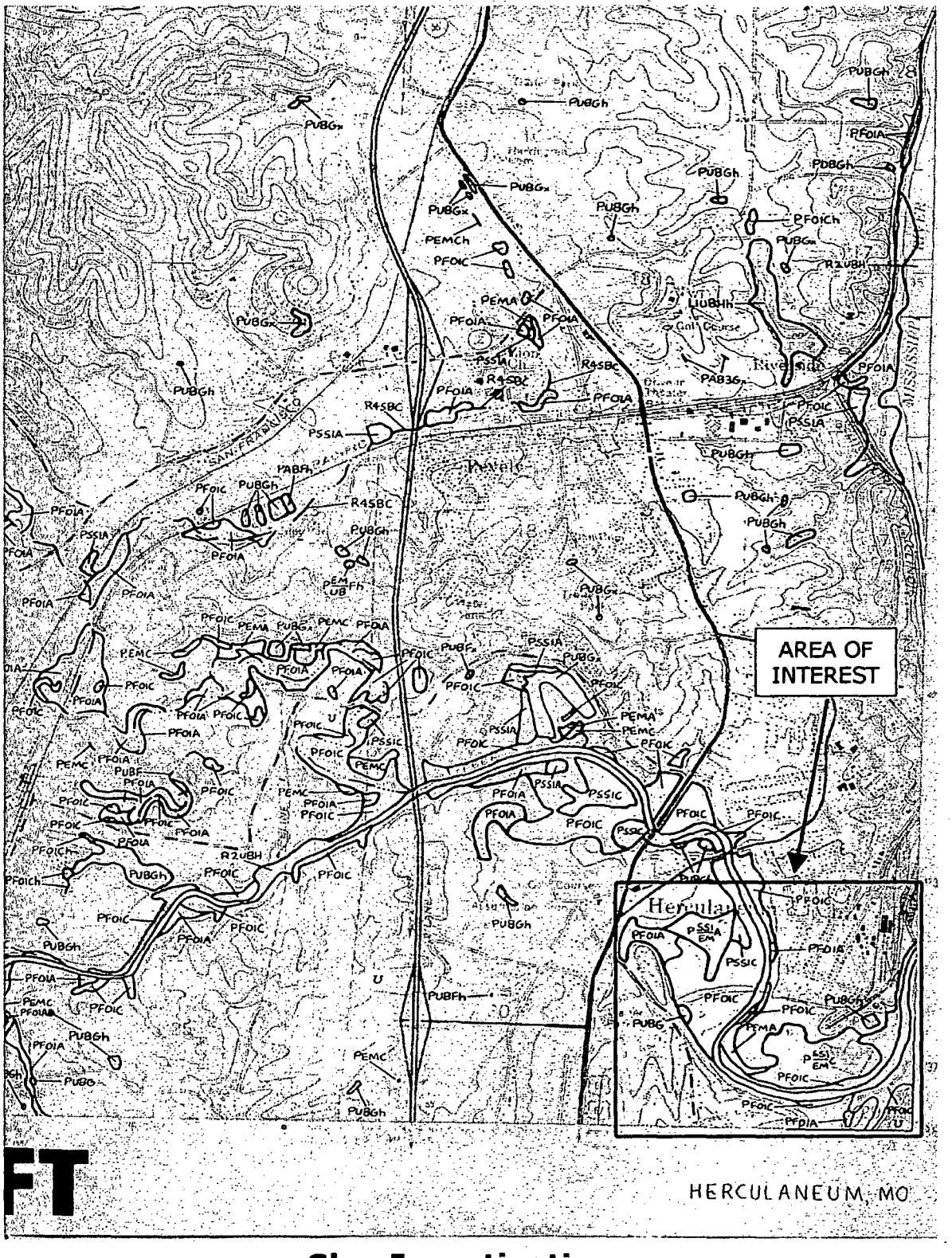


Slag Investigation
Historical Aerial Photograph
1993

Photograph obtained from the Jefferson County Soil & Water Conservation District

APPENDIX B
WETLAND INVENTORY MAP





Slag Investigation
National Wetland Inventory Map

Photograph obtained from the Jefferson County Soil & Water Conservation District

APPENDIX C

LETTER FROM THE MISSOURI DEPARTMENT OF CONSERVATION DESCRIBING NATURAL RESOURCES INFORMATION FOR THE HERCULANEUM AREA

MISSOURI DEPARTMENT OF CONSERVATION

Headquarters
2901 West Truman Boulevard, P.O. Box 180, Jefferson City, Missouri 65102-0180
Telephone: 573/751-4115 ◆ Missouri Relay Center: 1-800-735-2966 (TDD)

JERRY M. CONLEY, Director

Happy Holidays

December 15, 2000

Mr. Jeff Stringer
ELM Consulting
600 Hart Road, Suite 130
Barrington, IL 60010

Re: Natural Resources Information for the Herculaneum Area

Dear Mr. Stringer:

Thank you for your letter of November 13, 2000, regarding species of conservation concern within the Herculaneum area and Joachim watershed.

Review of our records show that public lands, species of conservation concern or sensitive communities are known to occur within the Joachim watershed. Please refer to the enclosed Heritage Database report for details. This report reflects information we currently have in our database and it should not be regarded as a definitive statement as to the presence or absence of species of conservation concern or high-quality natural communities. We provide this information for planning purposes only. Additional on-site inspections may be needed to verify the presence or absence of such species or communities.

Joachim Creek, because of its high biologic diversity, has been identified by this agency as a priority stream and will receive administrative emphasis by St. Louis District staff.

This letter and report address threatened and endangered species, fish surveys and inventories, and macroinvertebrate surveys and inventories as requested in your letter. Additional natural resources information you requested should be obtained from other sources. Further information requests concerning this project should be directed to Ms. Karen Bataille who represents this agency as a trustee for natural resources damage assessment. She can be reached at our Conservation Research Center, 1110 S. College Ave., Columbia, MO, 65201, or by phone at (573) 882-9880 ext. 3215.

Thank you for the opportunity to review and comment.

Sincerely,

Mary Lyon

MARY LYON
POLICY ANALYST

Karen Bataille

KAREN BATAILLE
ENVIRONMENTAL SERVICES BIOLOGIST

ML:bg

c: Jim Dwyer, USFWS
Frances Klahr, DNR

Enclosure

ELM CONSULTING
600 HART ROAD, SUITE 130
BARRINGTON, IL 60010

NATURAL RESOURCES INFORMATION - HERCULANEUM AREA AND JOACHIM WATERSHED

The following species and/or natural communities are known to occur on or in the vicinity of the project site:

Scientific Name	Common Name	Federal Status	State Status	State Rank	Size/ Acres	Township/ Range	Sec.	Ownership
DOLOMITE GLADE					11	041N005E	27	PRIVATE
CLEMATIS FREMONTII	FREMONT'S LEATHER FLOWER			S3		041N005E	27	PRIVATE

Additional information for planning purposes:

Overwintering bald eagles may occur in the project area, as they are common winter residents in big river habitats and major lakes where they feed on fish.

Pallid sturgeons are big river fish that may range widely in the Mississippi River and Missouri River system. Because the preferred habitat and range of the species are unknown, any project that modifies big river habitat or impacts water quality should consider the possible impact to pallid sturgeon populations.

The project area occurs near a region of karst geology. These areas are characterized by subterranean water movement. Features like caves, springs, and sinkholes are common. Cave fauna are influenced by water pollution and other changes to water quality. Every effort should be made to protect groundwater in the project area.

FEDERAL STATUS - The federal status is derived from the provisions of the federal Endangered Species Act, which is administered by the U.S. Fish and Wildlife Service. The Endangered Species Act provides federal protection for plants and animals listed as Endangered or Threatened. E = Endangered, T = Threatened, C = Candidate, PE = Proposed Endangered for Federal listing.

STATE STATUS (E) -The state status is determined by the Department of Conservation under constitutional authority. Rule 3CSR10-4.111Endangered Species of the *Wildlife Code of Missouri* and certain state statutes apply to state Endangered species.

STATE RANK - A numeric rank of relative endangerment based primarily on the number of occurrences of the species within the state of Missouri. S1 = Critically imperiled in the state, S2 = Imperiled in the state, S3 = Rare and uncommon in the state.

Heron rookeries, eastern collared lizard populations, natural communities and geologic features are recognized as sensitive biological resources and may also appear on this

APPENDIX D

ARMY CORPS OF ENGINEERS ROUTINE WETLAND DETERMINATION DATA FORMS DESCRIBING FOUR DATA POINTS IN THE SLAG INVESTGATION AREA

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Slag pile area, Site #1
Applicant/Owner: Doe Run Company
Investigator: Ward Lenz, Kathrine Kelley

Date: March 24 1999
County: Jefferson
State: Missouri

Do Normal Circumstances exist on the site? (Yes) No
Is the site significantly disturbed (Atypical Situation)? Yes (No)
Is the area a potential Problem Area? Yes (No)
(If needed, explain on reverse.)

Community ID: 1
Transect ID:
Plot ID: 1
Mapped as 1-1

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. Ulmus americana	T	FACW-
2. Acer saccharinum	T	FACW
3. Carex spp.	H	?
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). ≥66%

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

___ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)
Depth to Free Water in Pit: _____ (in.)
Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:
Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- X Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- X Local Soil Survey Data
- X FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Slag pile area, Site #1 Applicant/Owner: Doe Run Company, Herculaneum, MO Investigator: Ward Lenz, Kathrine Kelley	Date: March 24, 1999 County: Jefferson State: Missouri
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes (No) (If needed, explain on reverse.)	Community ID: 1 Transect ID: Plot ID: 2 Mapped as 1-2

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Ulmus americana	T	FACW-	9.		
2. Carex spp.	H	?	10.		
3. Acer saccharinum	T	FACW	11.		
4. Apocynum cannabinum	S	FAC	12.		
5. Salix nigra	T	OBL	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). ≥ 80 %

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

___ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)

Depth to Free Water in Pit: 6 (in.)

Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- X Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- X Local Soil Survey Data
- X FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Slag pile area, site #1	Date: March 24, 1999
Applicant/Owner: Doe Run Company, Herculaneum, MO	County: Jefferson
Investigator: Ward Lenz, Kathrine Kelley	State: Missouri
Do Normal Circumstances exist on the site? (Yes) No	Community ID: 1
Is the site significantly disturbed (Atypical Situation)? Yes (No)	Transect ID:
Is the area a potential Problem Area? Yes (No)	Plot ID: 3
(If needed, explain on reverse.)	Mapped as 1-3

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Carex Spp	H	?	9.		
2. Fraxinus pennsylvanica	T	FACW	10.		
3. Salix nigra	T	OBL	11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). ≥ 66%

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

___ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)

Depth to Free Water in Pit: 6 (in.)

Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- X Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- X FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Proposed slag pile, site #2 Applicant/Owner: Doe Run Company, Herculaneum, MO Investigator: Ward Lenz, Kathrine Kelley	Date: March 24, 1999 County: Jefferson State: Missouri
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes ~~No~~ (If needed, explain on reverse.)	Community ID: 2 Transect ID: ____ Plot ID: 1 Mapped as 2-1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. ACER Saccharinum	T	FACW	9.		
2. ULMUS AMERICANA	T	FACW-	10.		
3. Fraxinus pennylvanica	T	FACW	11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

___ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)

Depth to Free Water in Pit: 7 (in.)

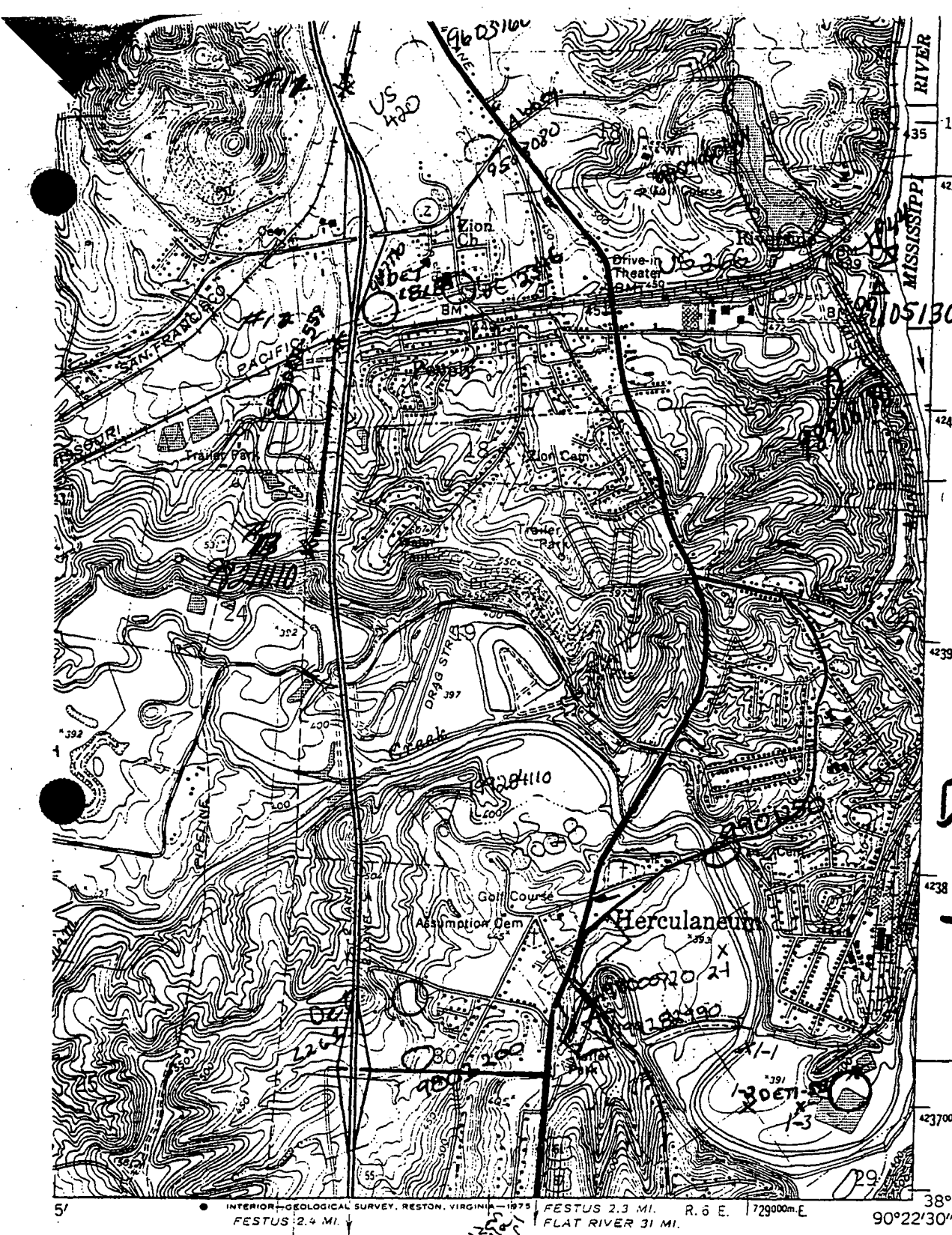
Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- X Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- X Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- X FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:



17'30" Mic. 153.7

Scale 1" = 2000'

Wetland Determinati

Data

Site.

ROAD CLASSIFICATION

Heavy-duty ——— Light-duty ———

Medium-duty ——— Unimproved dirt - - - - - -

Interstate Route U. S. Route State Route

QUADRANGLE LOCATION

HERCULANEUM, MO.

SW/4 KIMMSWICK 15' QUADRANGLE
N3815—W9022.5/7.5

1954

PHOTOREVISED 1968 AND 1974